THE GEOGRAPHICAL REVIEW

CONTENTS FOR JANUARY, 1934

	PAGE
The Long Beach Earthquake *By W. M. Davis*	1
Physiographic Results of a Recent Survey in Little Tibet *By H. de Terra*	12
White Settlement in Saba Island, Dutch West Indies *By A. Grenfell Price*	42
The Population of the Malay Peninsula: A Study in Human Migration *By C. A. Vlieland*	61
The Murray River Basin *By Charles Fenner*	79
Climatic Years *By Richard Joel Russell*	92
An Eskimo Discovery of an Island North of Alaska *By Vilhjalmur Stefansson*	104
Discovery of a New Sketch of Cape Hudson in the Antarctic *By William Herbert Hobbs*	115
The Altitude and Location of Minya Konka *By Richard L. Burdsall*	118
A National Plan for American Forestry *By Henry S. Graves*	129
American Geographical Society	134
Geographical Record (*listed on the next page*)	136
Geographical Reviews (*listed on the next page*)	154

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GEOGRAPHICAL RECORD

NORTH AMERICA

Climatic Conditions in Relation to Forest-Fire Hazard 136

Regional Planning for New York; Population Statistics of New York and Boston 136

Geological Guidebooks to the United States 138

Some Land Forms of California 138

Rejuvenation by Fault Coast Formation in Northern Canada. *By M. A. Peacock* .. 139

SOUTH AMERICA

Observations on Climate and Disease in Ecuador. *By Joseph H. Sinclair* 139

The Sugar-Loaf Knobs of Southeastern Brazil. *By Preston E. James* 141

EUROPE

Land Settlement in Latvia and Its Application in Germany. *By Eugene Van Cleef* 141

The Volcanic Region of Central Spain. *By W. E. Rudolph* 142

AFRICA

Water Supply and Allied Problems of Bechuanaland 143

ASIA

The Tide in Japanese Waters. *By H. A. Marmer* 144

Glaciers of the Shayok, Nubra, and Karakash Basins. *By H. de Terra* 145

New Political Subdivision of Outer Mongolia. *By N. N. Krijanovsky* 145

AUSTRALASIA AND OCEANIA

Lakes of the Central Plateau of Tasmania. *By Griffith Taylor* 146

The Hawke's Bay Earthquake 147

POLAR REGIONS

Two Antarctic Expeditions 147

WORLD AS A WHOLE AND LARGER PARTS

Mountaineering in Scotland and in the Northeastern United States Contrasted 148

Study of the Quaternary in Russia. *By Ernst Antevs* 149

PHYSICAL GEOGRAPHY

Stray Sea Birds and Atlantic Storm Tracks. *By Robert Cushman Murphy* 151

HUMAN GEOGRAPHY

Problems of Population 152

OBITUARY

Major C. K. Cochran-Patrick; Lieutenant George R. Johnson 153

GEOGRAPHICAL REVIEWS

H. C. WILLETT. **American Air Mass Properties.** *By Phil E. Church* 154

WARREN S. THOMPSON AND P. K. WHELPTON. **Population Trends in the United States.** *By E. B. Wilson* 156

WILLIAM M. MCGILL. **Caverns of Virginia.** *By W. M. Davis* 157

E. W. GILBERT. **The Exploration of Western America, 1800–1850: An Historical Geography** 158

ELLEN CHURCHILL SEMPLE. **American History and Its Geographic Conditions** 159

CLARENCE FIELDEN JONES. **Manual to Accompany American History and Its Geographic Conditions** 159

OTTO MAULL, FRANZ KÜHN, KARL TROLL, AND WALTER KNOCHE. **Süd-Amerika in Natur, Kultur und Wirtschaft** 159

F. E. PLUMMER. **Aspects of Rainfall in the Western Cape Province: A Basis for Geographical and Agricultural Study.** *By Mark Jefferson* 161

GEORG WOLFRAM AND WERNER GLEY, edits. **Elsass-Lothringischer Atlas: Landeskunde, Geschichte, Kultur und Wirtschaft Elsass-Lothringens** 162

Landesplanung im engeren mitteldeutschen Industriebezirk: ihre Grundlagen, Aufgaben und Ergebnisse 162

Atlante internazionale del Touring Club Italiano 162

M. WEHRLI. **Neue Völker- und Sprachenkarte von Europe, 1 : 10,000,000** 163

J. HOLLAND ROSE, A. P. NEWTON, AND E. A. BENIANS, edits. **The Cambridge History of the British Empire, Vol. 7.** *By A. Grenfell Price* 164

DOUGLAS M. GANE. **Tristan da Cunha: An Empire Outpost and Its Keepers, with Glimpses of Its Past and Consideration of the Future** 166

EDGAR AUBERT DE LA RÜE. **Étude géologique et géographique de l'archipel de Kerguelen.** *By G. W. Tyrrell* 167

CAMILLE VALLAUX. **Géographie générale des mers.** *By H. A. Marmer* 168

GEORG WÜST. **Das Bodenwasser und die Gliederung der Atlantischen Tiefsee.** *By H. A. Marmer* 170

HENRI GAUSSEN. **Géographie des Plantes** 172

MARCEL PRENANT. **Géographie des Animaux** 172

E. V. WULFF. **Introduction to the Historical Geography of Plants.** *By C. C. Nikiforoff* 173

PAUL KRISCHE. **Landwirtschaftliche Karten als Unterlagen wirtschaftlicher und kulturgeschichtlicher Untersuchungen.** *By C. F. Marbut* 174

YOUSSOUF KAMAL. **Monumenta cartographica Africae et Egypti** 175

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PARTIAL LIST

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Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

THE GEOGRAPHICAL REVIEW

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THE LONG BEACH EARTHQUAKE

W. M. Davis

FIG. 1—The area of principal damage (shaded) in the Long Beach earthquake. The epicenter is indicated (star) and the Inglewood fault (heavy line) and its probable extension. (After a map by A. C. Chick, see footnote 10.)

The Long Beach, California, earthquake of March 10, 1933, will be less remembered by reason of its contributions to seismology—for as a crustal tremor there was nothing especially remarkable about it—than it will be for having broken down the "hush-hush" policy that has hitherto been followed by the commercial organizations of the cities of southern California. It has most fortunately compelled public avowal by the most important of those organizations that earthquakes are a recurrent risk in their magnificent region and that the risk must be met by safer construction of buildings. But the loss of 120 lives and property destruction estimated at more than $50,000,000 are a high price to pay for such wisdom.

The Long Beach earthquake may be described as a fairly strong local shock. The area seriously shaken extended southeastward from the southern border of Los Angeles, past Long Beach, for about 40 miles, with a breadth of 15 or 20 miles. The larger area of moderate damage included the business district and the southern part of the city of Los Angeles—the damage there approached $1,000,000—and most of the towns located on the coastal lowland in Los Angeles and Orange counties. The shock was felt over an area about equal to that shaken by the Santa Barbara earthquake of 1925[1] and was of about the same intensity as that shock; but its energy was vastly less than that of the San Francisco earthquake of 1906.[2] It was not preceded

[1] Accounts of the Santa Barbara earthquake of 1925 may be found in the *Bulletin of the Seismological Society of America* for 1925 and 1927.

[2] A. C. Lawson and others: The California Earthquake of April 18, 1906: Report of the State Earthquake Investigation Commission, *Carnegie Instn. Publ. No. 87*, Vol. 1, Washington, 1908.

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by any so-recognized fore-shock, nor was it accompanied by any so-called "tidal wave," but it was followed by hundreds of minor after-shocks. It is believed to have been caused by a small slip on the southeastward submarine extension of the Inglewood fault, which passes through a southwestern suburb of Los Angeles and on which a tremor was felt in 1920;[3] but no displacement has as yet been discovered on the visible segment of that rift. The center of movement, as determined by automatic time records of the arrival of earth-crust waves at several stations maintained by the Pasadena Seismological Laboratory of the Carnegie Institution of Washington,[4] lay beneath the sea at a depth of about six miles, under a point in latitude 33° 34.5′ N., longitude 117° 59′ W., or 3½ miles off from the shore resort of Newport Beach, which is 35 miles southeast of Los Angeles and 20 miles southeast of Long Beach.[5] The shock is calculated to have begun there at 8 seconds after 5.54 p. m., Pacific standard time. It reached Long Beach a few seconds later. Movement there described as "hard shaking" lasted a number of seconds but less than half a minute.

In spite of exaggerated reports of its destruction, Long Beach was by no means reduced to ruins. Figures 2 and 3 are introduced as examples of lofty buildings that survived the shock. On the other hand, many buildings suffered severely (Figs. 4–6), as will be told below, and but for the fortunate chance that the shock occurred after the schools had been dismissed for the day the loss of life would have been terrible because of the disgraceful fact that "severe damage to school buildings was general."

Geological Relations[6]

Southern California is traversed by a number of generally northwest-southeast-trending fault systems, on which the horizontal component of movement is directed to the northwest on the Pacific side. It is believed that the heavy crustal slabs, several miles in thickness, between these faults are in continuous but very slow motion. Where in contact they are under heavy strain due to the friction of slab on slab. When and where the movement of a slab has gone so far that the

[3] Stephen Taber: The Inglewood Earthquake in Southern California, June 21, 1920, *Bull. Seismol. Soc. of America*, Vol. 10, 1920, pp. 129–145. Taber states explicitly that "the physiography, geology, and the recent seismic history of the Los Angeles coastal plain, remind us that earthquakes are to be expected in that area from time to time."

[4] H. O. Wood: Preliminary Report on the Long Beach Earthquake, *Bull. Seismol. Soc. of America*, Vol. 23, 1933, pp. 43–56.

[5] Later studies, especially one by Dr. Thomas Clements (Notes on the Fall of Columns During the Long Beach Earthquake, *Science*, Vol. 78 (N.S.), 1933, pp. 100–101), have suggested that while the first shock took place at the point thus located, it "touched off" one or more stronger shocks farther north on the same rift, nearer the points where the greatest destruction was caused. The small amount of destruction in Newport Beach, where all buildings stand on the sand of a broad sand spit supports this suggestion.

[6] This section is based in part on a report made by J. P. Buwalda, professor of geology, California Institute of Technology, at a meeting of the Los Angeles Section of the American Society of Mechanical Engineers on April 12, 1933, an abstract of which appeared in *Science* for August 18, 1933.

marginal strain overcomes the friction, a slip occurs then and there, and an earthquake is felt thereabouts, not because of any sudden movement in an entire slab, but because a local slip has relieved the accumulated strain between two adjacent slabs. It may require a century to provoke such a slip, "but not until man has lived in California one or two thousand years can accurate judgments be made of that matter."

The famous San Andreas rift, a 20-foot movement on which caused the San Francisco earthquake of 1906, is the farthest inland and by far the longest of the faults, passing from 30 to 50 miles from Los Angeles. The Inglewood fault is the southwesternmost and one of the shortest of the faults. The fissures of the fault systems are neither simple, rectilinear, nor parallel. The crustal slabs into which they divide the region have been tremendously tortured in the process of being dragged past one another and are subdivided by a complexity of minor faults. Slips may occur on any of the fractures. It is impossible to select any part of the populous southern California region, here considered, as exempt from earthquake hazard. It is otherwise with the area to the northeast, which, judging by its smoothly degraded surface forms, appears to have been undisturbed by faulting for a very long time. Unfortunately, however, this is the barren Mohave Desert, where settlements are few and far between.

The severity of earth tremors does not depend only on nearness to the fault slip that excites them; it depends also on the nature of the ground where the tremors come to the surface. Their oscillatory movement is less in firm rock than in alluvium; and if the alluvium is water-soaked, so much the worse, for its mobility is thereby increased. It was for this reason that both Long Beach and Compton, a smaller community midway between Long Beach and Los Angeles, suffered so severely last March, in spite of their considerable distance from the earthquake center. Both lie on an alluvial plain. Compton, which had a greater proportion of its buildings destroyed than any other town, is situated on a low part of the plain, some of which is swampy. On the other hand, the shore resorts of Corona del Mar and Laguna Beach, respectively east and southeast of the epicenter and less than half as far from it as Long Beach, suffered comparatively little damage, apparently because they are built on a rock platform of marine abrasion 50 or 100 feet above sea level and thinly covered with dry alluvium. In view of these facts, it seems that the fundamental cause of the heavy damage at Long Beach was unescapable; but the secondary cause of the damage, poor building construction, is escapable.

Report of the Committee on Earthquake Protection

Directly after the earthquake the importance of expert study of its effects was urged upon the California Institute of Technology,

FIGS. 2 and 3—Examples of lofty buildings in Long Beach that survived the shock.

Figures 2 to 6 are from a collection of several hundred photographs by the Portland Cement Association, Los Angeles.

whereupon the Joint Technical Committee on Earthquake Protection was organized with members chosen from the most competent physicists, geologists, engineers, architects, fire underwriters, educators, and business men of the region. The chairmanship was accepted by Dr. R. A. Millikan, chairman of the executive council of the Institute, and the vice-chairmanship by Professor R. R. Martel, also of the Institute and a leading expert in the engineering problem of earthquake-resistant building construction. Thus a great advance was made, a step taken that for years past had been prophetically urged upon California municipalities by seismologists, notable among them Professor Bailey Willis of Stanford University.

The objective frankness of the committee's report will be shown below; but we must preface it with a quotation from an accompanying statement by the president of the Los Angeles Chamber of Commerce—a state-

ment significant for its courageous recognition of earthquake risk in southern California as a matter of practical business as well as of scientific inquiry.

The entire intent of this report is to acquaint responsible public bodies generally with the fact that we have a natural condition to face, exactly in the same manner that we have heretofore faced and successfully met the need of a larger water supply . . . We believe that a comprehensive statement of the true facts, based upon scientific findings and building construction truths, is most timely and instructive and certainly should be considered carefully by all public bodies, institutions, and individuals, who are in any way responsible for the safety of lives and property in this area. . . .

Therefore, the Los Angeles Chamber of Commerce freely recognizes the truths as expressed in this report and commends the committee upon its findings and furthermore recommends to all governing authorities and responsible public groups that this report be seriously considered in the spirit in which it is presented.

And now for the report itself.[7] It had for its declared object

[7] Earthquake Hazard and Earthquake Protection, Joint Technical Committee on Earthquake Protection, Los Angeles, Cal., June, 1933.

FIGS. 4 to 6—Examples of buildings seriously damaged. Figure 4 (top), a school in Long Beach; Figure 5 (center), the city hall, Compton; Figure 6 (bottom), an apartment house, Long Beach.

To determine the effect of the earthquake, the reasons for the large loss of life and severe property damage, and the steps which should be taken to minimize the effects of future earthquakes. . . .

Earthquakes have occurred in California for a long period in the geologic past and it is extremely probable therefore that they will recur from time to time in the future. . . . Shocks of large magnitude were recorded in 1769, in 1812, and in 1857 . . . These earthquakes . . . were much greater in intensity . . . than the Long Beach earthquake, and it is not improbable that an even stronger earthquake may occur some time in the future.

Contrary to popular conception, the hazard of destruction by an earthquake is not limited to the area along a fault. Actually, the earthquake risk in southern California varies somewhat from place to place, but . . . in general it must be considered that the risk . . . does not differ greatly throughout this entire region . . .

There is reasonable probability, if not virtual certainty, that at some time in the future an earthquake of destructive intensity will cause great loss of life and damage to property, unless adequate protective measures are carried out. . . .

A summary states:

(a) Earthquakes of damaging or destructive intensity will continue to occur in California from time to time in the future.

(b) An earthquake is apt to occur in this region comparable in intensity and duration with the San Francisco earthquake of 1906.

(c) The risk of damage or destruction of buildings and other structures, and attendant loss of life, varies somewhat but not greatly throughout this region.

(d) The degree of risk is such that earthquake resistant construction is absolutely necessary in this region in order to avoid great loss of life and heavy damage to property.

And again:

An earthquake of the intensity and duration [about one minute] of that which occurred in San Francisco in 1906 may occur at any time at almost any place in this entire region. . . .

Had these emphatic statements appeared only in a scientific journal, they might pass unnoticed by the public; but they are actually published by an important commercial organization, with an approving note that begins by announcing that "the Los Angeles Chamber of Commerce not only has familiarized itself with the findings in this accompanying report . . . but has, through its own studies and investigations, arrived at the same general conclusions as are contained therein." Verily, the world does move!

Damage to Property

The statements concerning damage to property may be summarized as follows: Most of the modern office buildings in the zone of severe damage were of fireproof skeleton-frame construction; many of these buildings—although still standing, apparently unharmed—suffered considerable hidden structural injury. All too prevalent are "the stores and apartment houses which were built as cheaply as the

inadequate building codes would permit by those who were interested only in speculative profits." In the zone of severe damage hundreds of unsound buildings were wrecked; as a class they account for a large part of the toll of property loss. While a great many of the residences in the affected area were likewise built to sell, they were almost always of wood-frame construction. A certain amount of diagonal bracing is customary in the erection of a wood-frame structure, and the weight of the building is small; consequently the inherent stability of the single-family residence is high. Injury to this type of structure was largely limited to cracked plaster, broken tile roofs, and fallen brick chimneys.

The most scandalous disclosure was that of the general weakness of the schoolhouses. On this point the report says:

> In every community where the earthquake was at all intense, severe damage to school buildings was general. Auditoriums collapsed, walls were thrown down, and the very exits to safety were piled high with debris which a few moments before had been heavy parts of towers and ornamental entrances. . . . Boards of Education were evidently most concerned with the size of the school buildings and their appearance. Actual or assumed financial limitations prevented the selection of the best type of construction, and legal requirements forced the letting of contracts to the lowest bidder who could secure bond. It is evident that this point of view is unsound and the economy false. . . . School buildings must be so re-designed and strengthened that a repetition of the recent disaster can not take place.

Earthquake-Resistant Construction

Inasmuch as the *Geographical Review* is devoted to a science in which the sociological factor is of large importance, we may appropriately dwell on this example of delayed response of human behavior to seismic environment. The delay is due in part to ignorance, for the population of southern California is derived largely from regions where the risk of earthquakes is small; but this ignorance is partly willful, for warnings of risk have been more scoffed at than listened to, and is largely actuated by selfishness and greedy snatching at immediate profit. Southern California has recklessly neglected to adopt standard designs of earthquake-resistant construction such as have already been adopted in Japan, Italy, and New Zealand. The main features of such designs are that all walls shall be capable of withstanding, at every level, a horizontal force equal to at least one-tenth of the superincumbent weight; that slender structures, such as towers, high chimneys, and elevated tanks, shall be able to resist at every point a horizontal force equal to one-third of the weight above; and that parapets, cornices, and other exterior ornamental structures shall withstand a horizontal force equal to their entire weight.

The extra cost of such safe construction is not forbidding if it is met during the growth of a community; but, when it has been so long neglected that a large amount of reconstruction is demanded after an

alarming disaster, the total cost becomes burdensome. Thus Los Angeles now has had to meet as quickly as possible the expense of some $25,000,000 in restrengthening its existing schools. The unequivocal conclusion of the Technical Committee's report on this matter is as follows: "Damage to schools, which children are required by law to attend, was widespread, and it was only by chance that thousands of children were not killed. . . . No one can question the imperative necessity of prompt and effective correction of the weakness prevalent in the school buildings." Because the reconstruction or reconditioning of schoolhouses could not be completed by the date when the schools opened in the autumn, the schooling of many children is now proceeding more or less irregularly.

Report of the National Board of Fire Underwriters

The conflagration that is liable to follow an earthquake adds an extra risk to insurance in earthquake regions. The insurance companies' committees on fire protection thus become interested in the planning of municipal waterworks and in the construction of quake-resistant buildings. It is for these practical reasons that their engineers have made critical studies of the effects of various earthquakes. Some additional details on the Long Beach earthquake may now be presented from an able report by the National Board of Fire Underwriters.[8]

It is there stated that in the earthquake of March 10 "twenty thousand dwellings and two thousand apartment houses, stores, office buildings, factories, warehouses, theatres and churches were damaged in degrees varying from cracked plaster to complete destruction." In Compton the damage to business, industrial, and residential property amounted to 29 per cent of its total assessed value; in Long Beach to 9.4 per cent. The percentage for public and school buildings was considerably higher than these general averages. Complete collapse occurred chiefly in buildings in which the upper stories or roof trusses were supported on brick piers; partial demolition was greatest in front walls and parapets. The battering action of swaying roof trusses caused entire walls to be pushed out and thrown down.

The condemnation of schoolhouses is as severe as in the Technical Committee's report.

> Throughout the shaken area [they] suffered greater damage than any other class of buildings . . . Architectural effect seems to have predominated at the expense of strength and there was excessive use of ornamentation, towers, heavy copings on thin wall sections, and high parapets. A disturbing feature is that such unnecessary

[8] Report on the Southern California Earthquake of March 10, 1933, by the National Board of Fire Underwriters, Committee on Fire Prevention and Engineering Standards, New York, [1933], with outline map and many half-tone views. A limited number of copies of this report may be had on application by libraries to the Board at 85 John St., New York.

loadings of the structure were generally placed over doorways and passageways with the result that these exits were covered deep with debris. . . .

Buildings in which the architectural effects were predominant, such as churches and public buildings, were damaged much more severely than the ordinary commercial structures of plainer design and more regular shape. Such structures generally involve tall unbraced walls supporting the concentrated loads of heavy roof trusses. . . .

Poor workmanship contributed its share to the general destruction. The . . . mortar was frequently of a low grade and in some cases of wretched quality. . . .

Effects on the Tourist Industry

There are various southern California organizations that solicit the resort of tourists to their unquestionably attractive region. One is moved to inquire what effect on tourists the above-cited reports will have, in view of what is said in them as to the possibility of future earthquakes and the insufficiently quake-resistant construction of many California buildings. Geographers are familiar with the steep roofs of dwellings in regions where the snowfall is heavy and with the flat roofs of houses in warm and dry climates, that is with a relation of architecture to climate. Why should not a similarly appropriate relation of architecture to earthquakes be developed, that is a seismic architecture, where safety demands it? For instance, after reading the above warnings against the addition of parapets and cornices to roofs, it is somewhat disturbing to see, as one drives through the business sections of cities in the Los Angeles region, how very numerous such additions are. It would be a good thing if their removal were required as a measure of public safety. One of the cities in the region a few years ago displayed over its principal thoroughfare a sign reading, "Watch us grow." Might not that city now be persuaded first to remove its parapets and cornices and to strengthen its walls and then to display a sign reading, "Watch us grow safely"? But no, there is little probability of any such action or display. San Francisco is said to be relaxing already the building code it adopted in 1906.

It may be expected, however, that sooner or later the better hotels and apartment houses will be induced to have their construction inspected and certified by competent engineers, so that they may truthfully advertise such construction as quake-resistant. The inspecting engineers should not, for obvious reasons, be municipal appointees; they should be of the same independence and integrity as those employed, for example, by the Factory Mutual Fire Insurance Companies, which have been largely developed under the wise leadership of the late John R. Freeman, of Providence, than whom as authority on earthquake damage and insurance none stood higher.[9]

These mutual insurance companies—or "Factory Mutuals" as

[9] See his compendious volume: Earthquake Damage and Earthquake Insurance, New York and London, 1932.

they are known to the initiated—are carried on "without purpose of profit," solely for the protection of their members. They insure nothing but large manufacturing plants, of which they now cover upwards of 7500 in the United States and Canada, of a total value of more than ten billion dollars. The companies are wholly based on "fire prevention engineering." They employ more than 130 engineer-inspectors. By half a century of earnest and honest work they have reduced the fire loss in factories from an average of 33 cents per $100 a year, as it was from 1845 to 1875, to about 2½ cents between 1921 and 1931. Their service is of a special kind, applicable only to large concerns because of its high costs in inspection and engineering. It is referred to here in the hope that it may be possible to organize, in a correspondingly enlightened manner, a corps of inspectors under the direction of the various fire insurance companies that cover California hotels and apartment houses. How welcome would be an informing and thoroughly trustworthy report on California hotels similar to the one on Long Beach industrial structures recently made by A. C. Chick,[10] who gained his engineering experiences by work under Freeman for the "Factory Mutuals." If visitors coming to California would make it a practice to inquire about quake-resistant construction before choosing their hotels, the preparation of such a report would be hastened; but not one in a hundred visitors will know that there is such a thing as quake-resistant construction.

The timorous talk in the East about the dangers from earthquakes in southern California has probably increased since the Long Beach shock; but, as far as actual danger to an individual is concerned, such talk is of the same order as that touching the danger from rattlesnakes when excursions in the deserts of the Southwest are mentioned. During the past eight years I have made such excursions without number and have seen but one rattler, which was promptly killed by other members of my party. During most of the same period I have resided in California and have felt only the earthquake of last March. Moreover, during that time I have seldom heard earthquakes and their risks mentioned as subjects of ordinary conversation. Earthquakes are, indeed, not talked about enough in California. They should be explicitly referred to whenever the building, buying, or renting of a house is under consideration, and certificates of quake-resistant construction should be secured from a competent and unbiased expert.

However, a visitor to Italy does not avoid Naples or Palermo because of their proximity to active volcanoes or because of their

[10] A. C. Chick: The Long Beach Earthquake of March 10, 1933, and Its Effect on Industrial Structures, *Trans. Amer. Geophys. Union, Fourteenth Ann. Meeting, April 27, 28, 29, 1933*, Natl. Research Council, Washington, 1933, pp. 273–284. This report contains a large amount of definite and well illustrated information on the relation of building construction to earthquake damage. The 85 schools of Long Beach are estimated to have been 75 per cent damaged: on the other hand, a number of large buildings of quake-resistant construction suffered no injury. Briefer articles of similar tenor appeared in the *Engineering News-Record* for March 16 and 23.

liability to disastrous earthquakes such as, for example, the violent shock that, in July, 1930, caused the death of about 1500 persons and the destruction of hundreds of buildings in a district some 50 miles east of Vesuvius. Many persons moved away from San Francisco shortly after the earthquake and conflagration of 1906 but in spite of their withdrawal the city is now larger than ever before. It is probably true that many persons left Long Beach last March. But in spite of that sort of exodus Long Beach is destined to grow as the seaside resort of a great city, just as San Francisco is destined to grow because of its unrivaled harbor. Life is full of hazards, and we must take our chances among them. The chances of an enjoyable life in southern California are, in spite of its occasional earthquakes, undeniably excellent.

PHYSIOGRAPHIC RESULTS OF A RECENT SURVEY IN LITTLE TIBET

H. de Terra

Peabody Museum, Yale University

[With separate map, Pl. I, facing p. 40.]

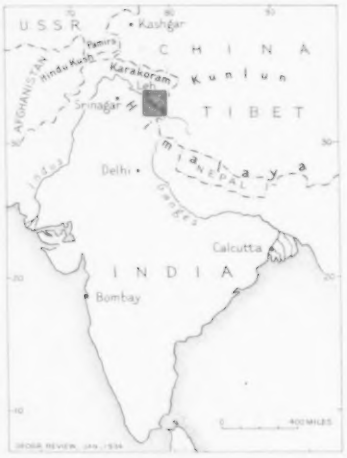

FIG. 1—The position of the region investigated: compare Plate I.

What makes eastern Ladak, or Little Tibet, so promising a field for exploration? Certainly it is not so much the spectacular scenery—for this lacks the great peaks, such as K_2 (28,250 feet), and the great snows and glaciers of the high Karakoram—as it is the central position occupied within the mountain belt between peninsular India and Central Asia. Geologically it is a key region lying between the southward-folded Himalaya and the northward-folded K'un-lun. Physiographically it forms a link between the high Karakoram in the northwest and the Tibetan ranges and plateau to the east. The youthfulness of the crustal disturbances and the recent enormous uplift of the ranges make the region a most promising field for an investigation into mountain building. These were some of the considerations that led to the organization of the Yale North India Expedition of 1932, an undertaking sponsored by Yale University. My choice of this particular mountain sector was determined also by the fact that I had become generally acquainted with Kashmir and Ladak in 1927–1928.

Epeirogenic upheavals in the southern Himalayas had been observed by Dainelli in 1913,[1] who estimated an 8000-foot rise of the Pir Panjal Range since the second half of the Pleistocene. My own observations confirm his view and lead me to conclude that young uplifts must have affected the entire Himalayan and Karakoram ranges. It was my plan to relate the study of land forms to that of their associated animal life, particularly the fresh-water life, and to investigate the limnological character of the great Himalayan rivers and of the high-altitude lakes with respect to their feasibility as a biological test for a geological process. Although the complexity of the problem calls for more data than this expedition was able to

[1] As described by F. De Filippi: The Italian Expedition to the Himalaya, Karakoram and Eastern Turkestan (1913–1914), London, 1932, p. 507.

gather in one year, it can be said that Mr. G. E. Hutchinson's[2] biological work has yielded important hints as to the ecologic status and relative age of the different limnologic facies in Kashmir and Ladak. A northern group, seemingly older than and different from the Kashmir and Indian fresh-water forms, was found to extend over the high upland along the Kashmir-Tibet boundary, with its remnants of an older relief and drainage pattern. Not only do relics of an older mammalian fauna (*Equus hemionus*, *Gazella picticaudata*, *Pantholops hodgsoni*) populate the last remnants of a gently rolling relief, but the fresh-water life as well seems to be related to Central Asian rather than to Indian forms. In order to contribute to our existing knowledge of the older Himalayan fauna, Mr. G. E. Lewis, of the Peabody Museum of Natural History of Yale University, was intrusted with collecting in the Tertiaries of the Himalayan foothills. His finds of fragmentary new anthropoid apes and of other mammals and my own discoveries in the Kashmir Valley of prehistoric implements with fragments of extinct species of elephants, fishes, and plants give new evidence as to the diversity and richness of life in the ancestral Himalayas. Such evidence points to surroundings that promoted rather than checked the evolution of a highly developed fauna. Prehistoric man, whose stone implements I traced from the Himalayan foothills across Kashmir to Baltistan, must have been benefited by the existence of large fresh-water lakes in the then less dissected mountains. The change in geographic conditions brought about by never-ending crustal movements even seems reflected in some of the older Indian mythologies, which probably hold the most ancient human traditions. And life older than man must have been most fatefully affected by the growth of the land, which ultimately evolved from a low mountainous and hilly country to the most elevated region on earth. To reveal the evidences for such an evolution as they are presented by the physiography is the general aim of this article.

The Topographic Survey

Attention must first be called to the map, Plate I, which presents the first detailed topographic work in the eastern portion of the area covered by the Survey of India Sheet No. 52 (1:1,000,000). Credit for this part of the program of the Yale North India Expedition[3] is due to the interest and encouragement of the American Geographical Society, and I wish especially to acknowledge the contribution of one of its

[2] G. E. Hutchinson: Limnological Studies at High Altitudes in Ladak, *Nature*, Vol. 132, 1933, p. 136.

[3] On the organization and personnel of the expedition see H. de Terra: Preliminary Report on the Yale North India Expedition, *Science*, Vol. 77 (N.S.), 1933, pp. 497–500; for a description of the route see *idem:* A Scientific Exploration of the Eastern Karakoram and Zanskar-Himalaya, *Himalayan Journ.*, Vol. 5, 1933, pp. 33–45. Leh was the starting point and terminus of the summer trip into western Tibet and the Karakoram Ranges (June to October, 1932).

FIG. 2—The north-to-south trending portion of the Chang-chenmo Range from the valley plain of Koh-lungpa. Note the salt lakes and glacier hidden beneath débris.

FIG. 3—Panorama of the northwestern portion of Lake Panggong from 3 miles south of Man at 17,100 feet.

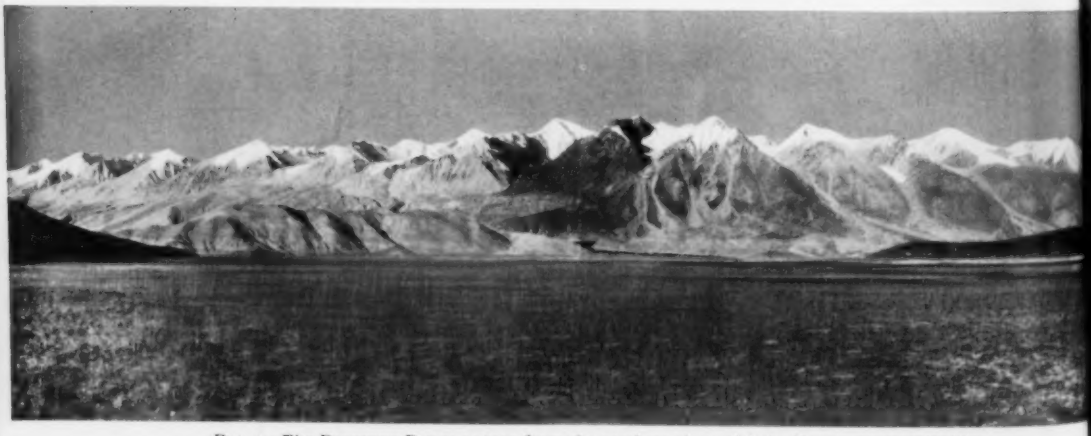

FIG. 4—The Panggong Range as seen from the northern shore of Lake Panggong opposite Man.

FIG. 2 (cont'd)—The summits are over 21,000 feet high. The view is from above camp Togarma at 17,226 feet (note the tents in the foreground).

FIG. 3 (cont'd)—The snowy crests of the Chang-chenmo Range constitute the background.

FIG. 5—Northern slope of the Zanskar Range south of Mahe, Ladak. Typical of the dissected mature relief of Rupshu at 16,600 to 17,000 feet.

members, whose generous support made it possible to engage a topographer and thus to provide a more substantial background for our other investigations.

The first topographic work in our region had been done as early as 1858, when Montgomerie of the Survey of India carried his triangulation series[4] into the upper Indus Valley. Godwin-Austen and Hayward (between 1861 and 1868) and various travelers, including Wellby (1896), Deasy (1898), Rawling (1903), and Hedin (1906), had provided data enough for the Survey of India to publish a set of maps on the scale of one inch to four miles. These maps showed the main triangulation points, but their broken contours indicated that the topography had been only roughly sketched. In many instances, as in the upper Chang-chenmo and Lingzi-tang, the hypothetical interpolations had led to gross errors; even the outline of Lake Panggong, which is much frequented by sportsmen, was inaccurate. Hedin's surveys in 1902 and 1907 were restricted to route maps and landscape sketching, the results of which were published in his great work,[5] of which the Survey of India made little use when newer editions of Tibetan and Kashmirian maps were issued. A boundary commission in 1924 and Trinkler's route map of 1927 did not add much information. Most welcome, therefore, was the willingness with which the Surveyor-General of India pledged his support for a detailed survey of part of this important borderland between Kashmir and Tibet. Through his courtesy a full surveying equipment was lent to us, and through his negotiations I was able to secure a most experienced mountain surveyor, the Khan Sahib Afraz Gul Khan, well known from his earlier surveys with Sir Aurel Stein, with Lieutenant Colonel Kenneth Mason, and with Mr. and Mrs. P. C. Visser. He plotted his plane-table sections for the proposed route before the actual fieldwork began, using the trigonometrical pamphlets of the Survey of India No. 52 F, G, H, J, K, L, N. He began his first sheet on the top of Digar La (Ladak Range) on July 22 and completed the last plane-table traverse on September 12, after having surveyed more than 4600 square miles. The slow progress of the expedition permitted the mapping to be carried out on the scale of two miles to one inch, with 100-foot contours. The total map comprises nine sheets and a special map of the morainic landscape at Man on Lake Panggong.

The main surveying instruments used were plane table, clinometer, rectangular magnetic compass, hypsometer, and, for leveling purposes, a Zeiss level with leveling staff. The plane-table fixings were based on the older trigonometric stations and points. Some new ones were

[4] J. T. Walker: Account of the Operations of the Great Trigonometrical Survey of India, Vol. 2, Dehra Dun, 1879; reference on pp. 16–17.

[5] Sven Hedin: Southern Tibet; text, 9 vols.; atlas, 4 vols.; Stockholm, 1916–1922.

computed, and in some places where the old stations were invisible a time survey was used, which was later checked by intersection with trigonometric points. There was an average control of 1.5 stations per day.

The weather was, with rare exceptions, perfect; the morning and late afternoon light never failed to bring out a relief of the most plastic expression. Evenings and days of rest and halt were used for inking in and determining heights, of which there were sometimes more than 500 on one sheet. The energy and tireless effort that the Khan Sahib put into this work deserve the greatest commendation, particularly when one realizes that most of his fieldwork was done at elevations of 16,000 to 19,000 feet.

Information concerning local names was gathered from local guides, who were engaged by the day or by the week. The original transcription of these Tibetan names was later corrected with the kind assistance of the Reverend J. Gergan of the Moravian Mission at Leh. The old maps were most incorrect in this respect, so a good transcription was consequently desirable. With the help of Mr. Hutchinson and of such books as A. H. Francke's "A History of Western Tibet" and Jaeschke's "Tibetan Grammar" a final check of the names was made.

My own geological fieldwork provided the regular survey with determinations of height by hypsometer and aneroid. The survey was equally valuable to the biologist, whose ecological and limnological studies required reliable data on heights of rivers, shore lines, terraces, etc. That the mapping resulted in a clearer conception of both geological and geomorphological features will become evident in the following discussion.

Structure of the Eastern Karakoram

From the high 18,000-foot passes of the Ladak Range the snowy ranges of the Zanskar-Himalayas to the southward and those of the southern and main Karakoram to the northward appear like giant waves following one another in perfect alignment (Fig. 6). The snowy crests of these ranges coincide generally with narrow belts of granite or gneissic rocks, the only exception to this rule being the range south of the Indus River, where the fossiliferous strata of the last great Himalayan sea (Lower Eocene) are folded to form peaks of 20,000 feet and more (Fig. 8). There also lies the thickest accumulation of ancient rock waste of the ancestral Karakoram—the Indus flysch, a 10,000-foot pile of detrital clastic sediments. This belt of softer but intensely folded strata is traversed by the largest drainage feature of the region—the Indus Valley, the natural boundary between the Himalayas and Karakoram. For 30 miles between

Spitok and Karu the river follows the plane of overlap—itself proof of a late Cretaceous uplift—between the basal beds of the flysch and the granite-gneiss of the Ladak Range. Newly discovered occurrences of similar flysch strata on the northern slope of the Ladak Range, near Chushul, and their overthrust here and along the Chang-chenmo by older rocks give proof of additional uplift in post-Eocene time, most likely between the Middle Oligocene and Lower Miocene.[6] The younger strata—the later Tertiary determined on lithologic grounds and the Pleistocene determined on fossil evidence—have been hardly disturbed in this region. Their formation took place subsequently to the folding processes.

These foldings determined the structural axes of the geologic formations that ultimately gave rise to the outer alignment of the various ranges. The northwest-southeast axis is dominant and continuous with that of the northwestern portion of the high Karakoram. But in the eastern part, from about longitude 78° 15′ E. on, the geologic backbone of this great mountain structure displays a most remarkable change in direction. For, whereas the granite axis of the range south of Chang-chenmo runs parallel to the course of this Tibetan river, it abruptly bends into a southeast-northwest direction where the Shayok breaks through its watershed (Fig. 6). The granite zone exposed on the Sassir La may be followed due southeast to where Hedin[7] and De Filippi[8] observed it again in the transverse gorge of the Shayok and thence to the headwaters of the Koh-lungpa. Its farther extension can now definitely be followed (Fig. 6) into Tibet, where it reappears in the form of monadnocks along the eightieth meridian south of Shum. The metamorphic schists and the younger calcareous formations north of the Chang-chenmo follow the example of the granite. South of Dapsang and around the Karakoram Pass they strike northwest-southeast, but as soon as they enter our region they are seen to take an eastward trend and to continue north of the lake basins of Panggong and Pangur. Particularly noteworthy is the similar behavior of the granite belt in the Ladak Range, which bends eastward near Nyoma on the Indus. Doubtless it continues in this direction as far as longitude 78° 50′ E., for Hedin[9] noted granite and diorite around the Tsaka La, extending north of the Indus as far as Gartok. Lydekker's map[10] indicated this bend of the granite belt, but, as it did not make a distinction between granite and metamorphic rocks, it gave the impression that the granite continues across the

[6] Previously (Geologische Forschungen im westlichen K'un-Lun und Karakorum-Himalaya (Wissenschaftliche Ergebnisse der Dr. Trinklerschen Zentralasien-Expedition, Vol. 2), Berlin, 1932) I was able to give evidence for only the older of the two foldings.

[7] *Op. cit.*, Vol. 5, Map A.

[8] *Op. cit.*, p. 288.

[9] *Op cit.*, Vol. 4, pp. 198 ff.

[10] R. Lydekker: The Geology of the Kashmir and Chamba Territories, and the British District of Khagan, *Memoirs Geol. Survey of India*, Vol. 22, 1883.

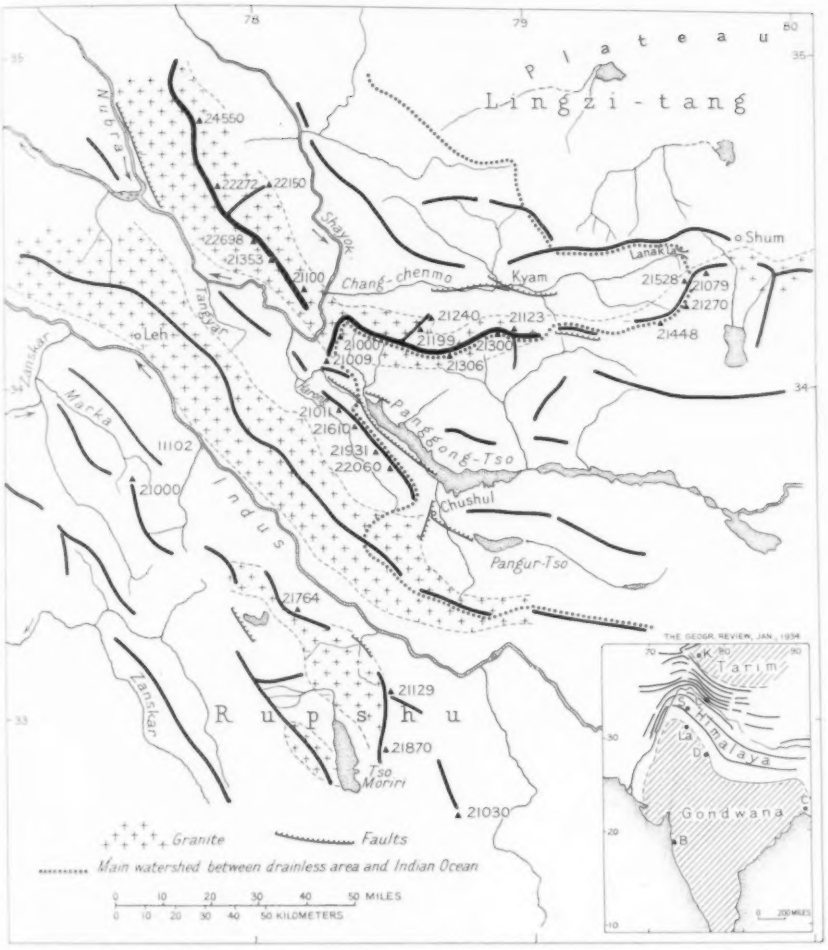

FIG. 6—Orographic sketch map of the eastern Karakoram and Zanskar-Himalaya in Ladak (Little Tibet). Scale 1 : 2,500,000.

Indus into Rupshu. In reality, the northeastern side of the transverse valley of the Indus is made up of crystalline schists similar to those that surround the Zanskar granite at Tso Moriri. The Indus therefore does not break entirely through the Ladak granite but only cuts into its southern slope.

The strict obedience of the crystalline axis to the change in strike of the flanking sedimentaries suggests that the granites, like those of the Alps, have been forced through orogenic pressure into the structural pattern that is the result of the major foldings. We must assume that this pressure came from the north, notwithstanding the fact that the general dip of the superficial folds and thrusts north of Panggong is distinctly southward. The bend in strike becomes apparent once more in the arrangement of the younger faults. In fact,

Panggong affords a striking example of a graben. The fault defining the northern shore bends from northwest-southeast to west-east and farther on probably determines the Tibetan outline of the lake to its end. Major fault lines, indicated by thermal action, are exposed near Chushul and in the Chang-chenmo at Kyam, where they locally cut the west-east folds. These dislocations are so well defined that they may be followed through the entire Karakoram system. They determine the courses of the main drainage lines, such as those of the lower and upper Shayok and Nubra valleys.

None of these features described from the Karakoram can be reported with reasonable certainty from the Himalayan side of our area. Although the granites appear also in ill defined ranges and faulting is locally in evidence, no sign of a similar bend in geologic strike can be noticed. Very likely the Zanskar-Himalaya, as Burrard[11] indicated, continue southeastward until they join the great Himalayan range.

From the foregoing it becomes evident that this region was land ever since the Eocene estuary of the late Tethys sea ceased to exist. Of post-Eocene and pre-Pleistocene strata there are scattered remnants left on the undissected higher land forms. We meet them, for example, as an ancient basin around the Lanak La (Fig. 7). Their lithologic character and stratigraphic position suggest that they are denudation products of the pre-Pleistocene relief. They are probably late Miocene to Pliocene in age, certain facies appearing to be the equivalents of the Siwaliks of the fringing foothills of the Himalayas and similar ossiferous deposits in Hundes, southwestern Tibet. They must represent a period of river erosion to which the intricate structure of the Himalaya and Karakoram was subjected. To this period and to such agencies are ascribed the outlines of the present relief.

Orographic Trends: The Zanskar Range

Since Godwin-Austen's brilliant attempt[12] to demonstrate the eastern extension of the Karakoram system into Tibet no further progress has been made in this direction—a fact that Burrard[13] has mentioned with resignation. The new topographic work of our expedition, supported by former observations made during the Trinkler expedition, now permits us to recognize here four distinct orographic groups (Fig. 6). In addition, there is one range south of the Indus that, although known to earlier investigators (Cunningham and Godwin-Austen), deserves brief attention.

[11] S. G. Burrard and H. H. Hayden: A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet, 4 parts, Calcutta, 1907–1908; reference in Part 2, p. 91.

[12] Presidential Address to the Geographical Section of the British Association, *Proc. Royal Geogr. Soc.*, Vol. 5 (N.S.), 1883, pp. 610–625.

[13] Burrard and Hayden, *op. cit.*, Part 2, p. 111.

This range, called Zaskar[14] by Burrard, is characterized by a line of higher peaks, all between 21,000 and 22,000 feet, which rise above a broad, often plateau-like but commonly dissected mountain range, the average elevation of which is about 19,500 feet. It is the northernmost range within the Himalayan system. In the region under discussion this Zanskar Range runs from southeast of Tso

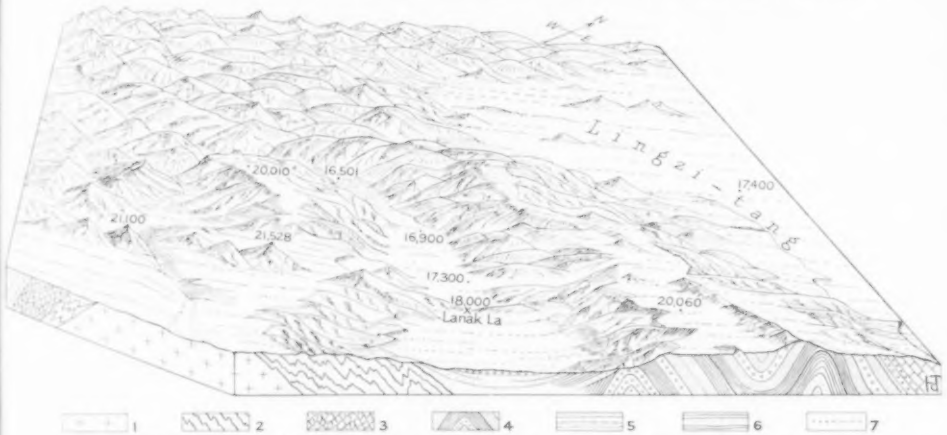

FIG. 7—Block diagram of the region around the upper Chang-chenmo Valley showing dissection of west Tibetan plateau. Numbers have reference: 1, Paleozoic Karakoram granite; 2, Paleozoic metamorphics; 3, Mesozoic limestones; 4, Carboniferous sandstones, shales, etc.; 5, arkosic red beds (Cretaceous-Eocene); 6, young Tertiary basin sediments. The vertical scale is exaggerated about five times.

Moriri across the lower Puga Valley to northeast of Lake Kar across the Taglang La (17,479 feet), south of Gya. From here on it strikes northwest to the junction of the Zanskar and Marka rivers. Apart from being characterized by higher snow peaks and locally extensive glaciation, it coincides to a large extent with the granite-gneiss belt of Rupshu. The latter feature helps to trace it farther northwestward, where I observed the same granite-gneiss near Kargil in Baltistan (about 76° E., 34° 35′ N.) at the bend of the Shingo River, whence it strikes southeastward, forming the prominent ridge south of the Wakka River. Its crystalline axis finally extends east of the Deosai, and it seems not unlikely that the Zanskar Range terminates only at the junction of the Gilgit and Indus rivers. Toward the southeast it may be definitely traced as far as geologic information permits, i.e. west of Hanle and possibly to the headwaters of the Sutlej. Minor changes in strike excepted, its orographic and geologic trend is northwest-southeast. Three shorter ranges, also locally glaciated but of lesser height (20,500 feet), accompany the Zanskar Range. The largest of these begins west of Tso Moriri in a belt of gneiss, which wedges out within a short distance, as Hayden[15] indicated.

[14] I prefer either Zanskar or Zangskar as used by Strachey in 1853, a transcription more in accordance with the Tibetan meaning "white copper."

[15] Burrard and Hayden, *op. cit.*, Part 4, geological map.

The Ladak Range

North of the Indus begins the Karakoram system, which is bordered to the north by the western K'un-lun and to the northwest by the Pamirs and Hindu-Kush. Its southernmost member is the Ladak Range named after Ladak ("Little Tibet or Maryul, the low country"). From the Shayok-Indus junction in the northwest it enters our region near Leh as a snowy range flanking the Indus Valley with an average height of 19,000 feet. It does not carry any prominent peaks and, seen from the south, presents a rather even skyline, like the edge of a plateau (Fig. 10). Southwest of Chushul it forms the watershed between the drainless lake basin of Panggong and the Indus. All maps show it to cross the Indus west of longitude 79° E., but its granite axis bends sharply west-east north of the very point where the Indus changes its course from northwest-southeast to southwest-northeast. The extension of the Ladak granite axis must therefore be looked for in the ridge east of Tsaka La, which extends into the Tibetan province of Rudok, south of the depression of Pangur and Nyak Tso.

The Panggong Range

Having crossed the Ladak Range on the Kaksang La, one descends toward Chushul and sees another snowy range rise very abruptly from the wide, lake-strewn valley plains. Seen from the shore of Lake Panggong, which reflects its jagged peaks, its deeply incised glacier troughs, and its steeply sloping spurs, it is most impressive (Fig. 4). It is no wonder Strachey[16] spoke of it as being higher than the other ranges, an impression warranted not so much by the number of high peaks as by the fact that this range is bordered by the deepest depressions, the Panggong and Harong valleys. For a distance of 35 miles between Tangtse and Chushul it contains no less than ten peaks exceeding 21,000 feet and one of 22,060 feet elevation, with double that number of glaciers on the northern side. The peaks are pinnacles reminiscent of the Aiguilles Rouges and Mont Blanc massifs in Switzerland, both of which have a gneissic composition. I shall call this the Panggong Range, after the native name of the whole lake district. Until the nomenclature of the Karakoram has been definitely settled, it seems advisable to designate the mountain ranges within this area by local names.[17] The Panggong Range, with diminished elevation, may be followed toward the northwest between Tangtse and Durbuk (Fig. 26), where it is cut by the river,

[16] H. Strachey: Physical Geography of Western Tibet, *Journ. Royal Geogr. Soc.*, Vol. 23, 1853, pp. 1–69; reference on p. 25.

[17] On this important question see "Mountain Names on the Indian Border," *Geogr. Journ.*, Vol. 74, 1929, pp. 274–277; Sir Sidney Burrard: The Mountains of the Karakoram: A Defence of the Existing Nomenclature, *ibid.*, pp. 277–284; "Himalayan Range Names," *ibid*, Vol. 75, 1930, p. 35; Kenneth Mason: Nomenclature in the Karakoram, *ibid.*, Vol. 76, 1930, pp. 143–158.

and thence north of the Tangyar valley up to the Shayok-Tangyar junction. Its course is probably continued in the belt of gneisses and metamorphic schists found in the Shayok-Nubra watershed and south of the great Siachen glacier. Like the Ladak Range, its eastern extension is determined by a bend at Chushul, whence a west-east strike continues north of the Pangur Tso. Here it loses its grand alpine relief, as if it merged into the rolling highlands of Tibet.

The Chang-Chenmo Range

From the shore of Lake Panggong and still better from a commanding point at the glacier snout south of Man one sees on the horizon due northwest, north, and northeast a high snowy range, extending from Muglib to the Marsimik La and then eastward (Fig. 3). From this distance it appears to be almost unbroken, very jagged to the northwest, but with few peaks surmounting snow-clad ridges to the north and northeast. In its western portion as far as the Marsimik La I sought for the extension of the main or Muztagh-Karakoram,[18] which here coincides with the northernmost granite belt characterized by a number of high peaks and the longest glaciers. The recent surveys supported the opinion of Trinkler and myself in that they showed the existence of 15 peaks of more than 21,000 feet between longitudes 78° 15′ and 79° 40′ E. Of these the main culminations occur west of the Koh-lungpa (Koh massif), south of Pamzal (Pamzal massif), south of Kyam (Chang-chenmo massif), and south of Lanak La (Tartary massif). None of these reaches a height of more than 21,528 feet, and they rise from ridges partly snow clad, the average elevation of which may be about 20,000 feet. From Figure 6 it can be deduced that this range follows the granite belt of Marsimik La and that it finally joins with the granitic massif south of Shum. It should be called the Chang-chenmo Range, after both the name of the native district and that with which the people from Pobrang designate also the mountains on both flanks of the valley. Stolitzka and the early trigonometrical surveys applied the same name particularly to the southern side. We thus have a tradition to follow. Unlike the other orographic units in our region, this range displays a west-east trend throughout its length, with the exception of its westernmost part, where the Shayok has cut a short north-south-trending portion out of a formerly broader range (Fig. 6). Here we meet once more with this peculiar flexure affecting orographic and geologic axes alike—a trend which Godwin-Austen's map also represented. Its significance, however, must have escaped his notice, for he then bends his Mustakh Range southeastward, where only younger and softer rock formations and no alignment of higher peaks appear.

[18] H. de Terra, Geologische Forschungen, p 4.

FIG. 8—Looking towards the Indus Valley and Zanskar-Himalaya from two miles north of Leh. Note terminal-moraine wall of last glaciation in foreground, low granite ridges in center and flysch strata in background, whence projects a series of spurs whose leveled tops indicate the old valley floor of the Indus.

FIG. 9—View from Lanak La to the plateau remnant (16,600 feet) north of Khyagar Tso. In the background is the Zanskar Range with its faceted spurs.

FIG. 10—The Indus Valley at Karu with the Ladak Range in the background (the dark spot at the right is the oasis of Karu 10,953 feet) and the Chimre Valley with flat-topped divide projecting from the snowycrest.

FIG. 11—The Ladak Range as seen from Shakya La (18,020 feet) toward Digar. High snow peaks of the Nubra-Shayok watershed are seen in the right background.

FIG. 12—Wide glacial trough valley of the upper Rimdi River, Chang-chenmo Range.

FIG. 13—A 21,249-foot peak south of Pamzal in Chang-chenmo Range. Note the terraces on the slope and the width of the Chang-chenmo Valley. Compare Figure 23.

FIG. 14—View from the foot of Lanak La toward the Tartary massif (21,528 feet). Note granite monadnock above plateau remnant (20,000 feet).

THE KARAKORAM-LINGZI-TANG RANGE

North of the Chang-chenmo Range we find another range distinctive from the morphologic point of view. It presents rounded or elongated ridges and divides practically without higher summits. Its position between the Lingzi-tang and the Chang-chenmo gives it a definite orographic character, which appears to become more prominent toward the west and northwest. Here, in a triangular group between the Kugrang, lower Chang-chenmo, and Shayok rivers, it displays a graceful curve of glaciated ridges following the great flexure of the entire mountain system. It is Godwin-Austen's Karakoram-Lingzi-tang Range,[19] which coincides with the first northern belt of young Paleozoic rocks and Mesozoic limestones.

THE REËNTRANT OF THE EASTERN KARAKORAM

Thus the four main ranges that constitute the eastern Karakoram bend from northwest-southeast to west-east approximately along the meridian of 78° 35′ E. Not only the Karakoram but the main Himalayan chain outside our area is subject to this reëntrant, which has only one counterpart within the same mountain belt—the great virgation of the Pamir, Hindu Kush, and Himalaya to which Suess[20] first called attention. Although different in character, the one being a grouping of divergent fold axes, the other a bending or simple reëntrant of a bundle of mountain folds, they both seem to reflect the peculiar northern outline of the old Gondwana mass to the south. Burrard[21] had already pointed to a parallelism between the Himalayan chain and the borders of the Indian tableland, but since then it has become possible[22] to reconstruct more of this northern outline of Gondwana.

[19] H. H. Godwin-Austen: The Mountain Systems of the Himalaya and Neighbouring Ranges of India, *Proc. Royal Geogr. Soc.*, Vol. 6 (N.S.), 1884, pp. 83–87 and map and sections.

[20] Eduard Suess: The Face of the Earth, Vol. 1, Oxford, 1904, p. 448; see also E. Trinkler: Das Problem der grossen Scharung in den Pamir-Gebieten, *Mitt. Geogr. Gesell. in München*, Vol. 16, 1923, pp. 1–12.

[21] Burrard and Hayden, *op. cit.*, Part 2, Chart 9.

[22] D. N. Wadia: The Syntaxis of the North-West Himalaya: Its Rocks, Tectonics, and Orogeny, *Records Geol. Survey of India*, Vol. 65, 1931, pp. 189–220.

FIG. 15—A plateau glacier east of Lanak La, western Tibet.

The isostatic geoid of India as constructed by Major E. A. Glennie[23] gives two contours south of the Himalayas, the southern one, on a line Lahore-Delhi-Fyzābād, corresponding roughly with the hypothetical border line of Gondwana as it can be reconstructed from the distribution of ancient rocks. It shows the bend from a northwest-southeast to a west-east direction along the seventy-eighth meridian. It is the nick in the border of Gondwana about 500 miles south of the eastern Karakoram that is reflected in the reëntrant of the Karakoram ranges—an explanation fully supported by the general conformity of geologic strike and orographic trend.

This relationship permits us to draw further conclusions. First, it lends support to Von Schlagintweit's[24] old idea of the extension of the high Karakoram into the Panggong and Chang-chenmo districts, for the reëntrant is in itself proof of an eastern continuation. Secondly, it becomes evident that this mountain system cannot be an extension of Hedin's Trans-Himalaya, for the main Karakoram axis should consequently be expected to continue south of Arport Tso into central Tibet. Also, the Kailas Range of Burrard cannot possibly be linked with the Shayok-Nubra watershed and with our Panggong Range. The latter most likely continues south of the Shaman Tso, thus avoiding Mount Kailas, which, as Hedin has shown, is geologically different from, and younger than, the gneiss belt of Panggong-Nubra. Accordingly, the Ladak Range should eventually merge with the "Nain Singh Range."[25] The newly observed trend of the Karakoram system points to a more northerly extension than hitherto supposed, namely north of the great Tibetan lake district. Most likely its natural extension is the Tangla Range, which stands out as a dominant orographic feature of central Tibet. Geologically the Trans-Himalaya seems more related to the Himalayas proper than to the Karakoram, with which it has hardly anything in common. This becomes especially apparent with regard to the different ages of the granites in

[23] Gravity Anomalies and the Structure of the Earth's Crust, *Survey of India Professional Paper No. 27*, Dehra Dun, 1932, Chart VII. See a discussion of Glennie's hypothesis in "A Challenge to Isostasy" by Chester R. Longwell, *Geogr. Rev.*, Vol. 23, 1933, pp. 682–683.

[24] H. von Schlagintweit-Sakünlünski: Reisen in Indien und Hochasien, Vol. 3, Jena, 1872, map.

[25] H. Trotter: Account of the Pundit's Journey in Great Tibet from Leh in Ladákh to Lhása, and of His Return to India Viâ Assam, *Proc. Royal Geogr. Soc.*, Vol. 21, 1876–1877, pp. 325–350.

both ranges, which are, if Hennig's interpretation be correct,[26] of Tertiary age around Kailas, whereas my studies show that they are of Paleozoic origin in the Karakoram. *For these reasons I hold the Trans-Himalaya to be a separate orographic unit*, which on further exploration may prove to be cis-Himalayan rather than trans-Himalayan in character.

Salient Morphologic Features: The High Mountains

Most characteristic of the area under consideration are those highly elevated plateau remnants in the northeastern sector that are surmounted by still higher land forms. Two lower relief units—dissected mountains and deeper depressions such as main drainage lines and lake basins—reshaped by Pleistocene glaciation and subsequent erosion complete the picture.

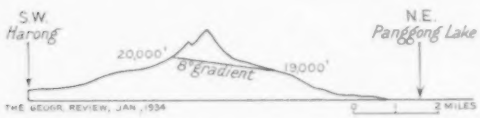

Fig. 16—Canting of snow line on Panggong Range.

In the first category are included the highest portions of the more important ranges discussed above—the Zanskar, Ladak, Panggong, Chang-chenmo, and Karakoram-Lingzi-tang ranges. Notwithstanding their great height, which is expressed by a mean summit level of 21,685 feet, they appear, with few local exceptions, not as sharp-wedged peaks but as serried summits that rise from broad shoulder-like mountains or ridges (Fig. 13). This feature differentiates them from the known Himalayan or high-Karakoram peaks. Where glaciation or proximity to deep erosion channels have not exerted their influence, the summits tend to form triangular or knob-like heights that show distinctly concave slopes. The high divides, mostly snow covered, from which these summits rise have precipitous flanks at 18,500 to 19,000 feet in the southern districts and at 19,500 to 20,000 feet in the plateau region around Lanak La. Apart from height, this relief unit is characterized by recent glaciation.

On its northeastern side the Panggong Range carries no less than 26 glaciers in a distance of 24 miles. Most of them are preferably described as "glacierets," for they do not exceed three miles in length (Fig. 17A). They begin in well defined cirques at an almost uniform level of about 19,000 feet. Bergschrunds are always in evidence, and the névé fields, in spite of their steepness, merge into the glaciers. Owing to a sharp break in the longitudinal profile of the high valley bottoms, some of the glacierets change abruptly from valleys into hanging glaciers of the pinnacled type. Toward the glacier snout appear *séracs*, some of which may be 20 feet high, while the snout itself is deeply cleft by crevasses, in which morainic débris accumulates to form esker-like masses. Terminal moraines are absent, for their

[26] Hedin, *op. cit.*, Vol. 5.

débris is quickly washed down the steep slopes, to accumulate in cones 1500 feet high (Fig. 4). Nivation, frost weathering, and solifluction combine to bring about rapid erosion in the summit region, to which must be added the effects of ice scooping and wedging. In spite of their smallness the Panggong glaciers advance to the lowest point (15,800 feet) at which recent glaciers were observed to exist in the area. This relative ice advance is doubtless due in part to the canting

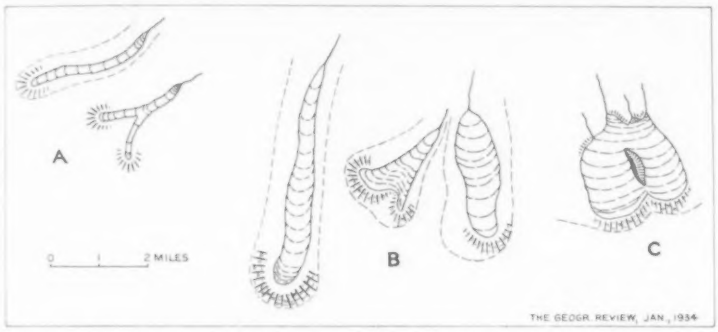

FIG. 17—Types of glaciers in the eastern Karakoram (100-foot contours on the glaciers). A, glacieret of Panggong Range; B, valley glacier of Chang-chenmo Range; C, Tibetan plateau (piedmont) glacier.

of the snow line (Fig. 16), apparently because of the greater precipitation and humidity on the lake side of the range. The northern exposure also promotes the existence of névé in shaded cirques, thereby supporting the advance of the narrow ice tongues. As regards secular or periodical changes, it must be admitted that, in the absence of terminal moraines and regular observations, no positive data are as yet available. A stone pyramid 660 feet below the snout of a glacier near Man (17,400 feet) may indicate a mark set up perhaps by H. von Schlagintweit in 1855[27] to locate the glacier front. Our surveyor was certain that this pyramid had not been erected as a trigonometrical station. It should be noted here that dead ice, so frequent around the glacier snouts of the high Karakoram,[28] does not exist here.

On the northern flank of the Chang-chenmo Range the glaciers are generally larger and longer (Fig. 18). They are valley glaciers of the alpine type, with broad névé fields projecting from peaks or ridges. In only one instance did I observe the "Turkestan glacier type" of Von Klebelsberg,[29] which derives from broken-down, regenerated névé masses at the foot of precipitous rock walls instead of from a regular névé field. Wherever longer glaciers (Fig. 17B) cross a break in the valley floor (i.e. the edge of plateau remnants) a change to hanging types can be noticed. Southern exposure leads to stronger

[27] *Op. cit.*, p. 171.

[28] Kenneth Mason: The Glaciers of the Karakoram and Neighbourhood. *Records Geol. Survey of India*, Vol. 63, 1930, pp. 214–278.

[29] R. von Klebelsberg: Beiträge zur Geologie Westturkestans, Innsbruck, 1922, p. 430.

FIG. 18—Peak, 21,190 feet, and glacier south of Pamzal in Changchenmo Range.

ablation and quicker deposition of débris, as is illustrated in the case of the upper Kohlungpa (Fig. 2).

Wider and flatter in appearance are the valley glaciers that flow from the high massifs (e.g. the Tartary massif and south of Shum) down to the open valley plains of western Tibet (Fig. 15). Locally they unite in the manner of piedmont glaciers to form small ice caps, 200–400 feet thick, with a steep ice front from which spring numerous rivulets (Fig. 17C). Some well defined valley glaciers show four successive terminal moraines, presumably indicating various stages of ice retreat in late Pleistocene or subrecent times. Usually accumulation is more noticeable than erosion, for the ice moves very slowly owing to the slightness of gradient of the valley floor. Such must also have been the case during the Ice Age, which has affected but little the land forms of the plateau region. The preglacial relief still continues to determine the phenomena of recent glaciation (Fig. 7).

Most surprising is the survival of dead ice in valleys bordering the Tibetan plateau. The Mitpal River one-half mile downstream from camp 34 crosses a large cake of unprotected valley névé, 3 feet thick, about 1500 feet long, and 600 feet wide (Fig. 19). The altitude is 15,900 feet (snow line at 20,000 feet), and the mass consists of coarse névé of granular texture and with well defined layers of dust separating strata one-eighth inch thick. Fans and streamers of talus on the sides of the valley indicate the repeated fall of avalanches. The névé must therefore have originated from the localized accumulation of snow to a depth sufficient to survive the following summers. We may assume that to this large mass were added the falls of winter, which, although melted away, protected the underlying older névé to some degree, especially as the latter acted as a local refrigerator. With night temperatures hardly ever rising above the freezing point, snowfalls beginning as early as August, and a soil frost-bound from October to May, such a process seems reasonable enough. Oddly, this same névé field was observed in 1848 by Strachey,[30] whose de-

[30] *Op. cit.*, p. 54.

scription made it equally thick but somewhat larger. The fact that a patch of névé could be maintained for 84 years in an open valley seems to argue against climatic oscillations of such magnitude as might otherwise be inferred from the changes of lake levels in the neighborhood.

FIG. 19—Valley névé in the Mitpal Valley at 15,900 feet.

The high mountains characteristically coincide with the distribution of the resistant rock formations (Fig. 6). In the case of the plateau border (Fig. 7) they appear as monadnocks surmounting the highest plateau level—a clear indication of preglacial planation. Of this the plateau remnants give indisputable evidence.

THE REMNANTS OF THE MATURE RELIEF

Plateau forms dominate in the northern corner of the area and also farther east of Lanak La, the frontier pass between Ladak and Kashmir. Figure 7 shows the high peaks of the Chang-chenmo Range rising out of remnants of a moderately rolling surface such as also appear, though less uniform, on the northern divide between the Lingzi-tang and the upper Chang-chenmo. From the facts that the plateau level is surmounted by monadnocks (Fig. 14) and that, on the other hand, it is characterized by wide basin-like valleys and fully graded rivers we conclude that this relief is in a state of late maturity. It is not a peneplain,[31] for, like all the other remnants of similar land forms in the Himalayas and Karakoram, this plateau carries residual summits, and it is interrupted by flat, unconsumed ridges and even, glaciated ranges (Fig. 25). However, when we connect the even levels about 20,000 feet with one another, we obtain a smooth reconstructed surface, with only a few snow peaks rising 1000 to 1500 feet above it and the Lingzi-tang as well as the main valleys appearing therein as slight depressions. Such seems to have been the earlier relief of western Tibet developed in the period that followed the last mountain folding. The wide planation that the level remnants imply

[31] Attention had been called to this by W. M. Davis in "Die erklärende Beschreibung der Landformen," Leipzig and Berlin, 1912, p. 271.

cut across complicated geological structures. At a later stage the drainage channels became choked with detritus, and fluvial sand and clays were deposited (Fig. 7). That the climate was rather humid is suggested by the lithologic character of the fluvial deposits and corroborated by the effectiveness of the lateral cutting by the ancient rivers. The valley floors, as terraces at 18,500 feet indicate, lay nearer to the level surface than they do nowadays, so that the maximum differences in height did not exceed 3000 feet. At that time the high intermontane basins of Lingzi-tang and Sumdjiling formed widened valley floors in this low relief, which deepened but little during the Pleistocene glaciation[32] and which must have broadened again under the subsequent aridity of a drainless region.

The region around Lanak La permits us to trace these old land forms toward the Karakoram. Figure 7 shows how the divide between the plateau and the middle course of the Chang-chenmo becomes more deeply dissected the farther we proceed toward the west and southwest. Here the plateau level is replaced by a summit level, the valley slopes steepen, and the valley floors narrow. Locally we find a clear superposition of plateau and terrace level (Fig. 13), and here also we notice a still lower level—between 16,000 and 17,000 feet. The latter, moreover, is not a local feature dependent on the lithology but is part of a widely extended surface form, which we meet again south of the Chang-chenmo Range. One can generally recognize an upper terrace level some 1200 feet above the present valley floors of the upper Mitpal, Koh, and Chagra rivers and just below the upper limit of recognized glacial erosion. This terrace presumably marks the older floor (level I of Fig. 21), which was much more profoundly modified than the plateau valleys because the more dissected preglacial relief lent itself to an intensive valley glaciation. It is noteworthy that many passes, such as Marsimik La (18,394 feet), that lie on the great watershed between the interior drainage basin and the Indus catchment area coincide with a similar high terrace level. The headwaters of the Koh and Mitpal rivers (Fig. 2) flow across very wide valley floors and are perfectly at grade. The Koh-lungpa, in fact, is reminiscent of the upper Chang-chenmo near Lanak La and seems like an outpost of the mature relief south of the main Karakoram range. Here are many other valleys of this kind (Fig. 3, center background), and the same floor level appears north of Lake Panggong (Fig. 21). Below this level lies a more dissected relief, with glacial troughs (Fig. 12) and exhibiting all the phenomena of glacial action.

The Panggong Range displays a most striking uniformity in the

[32] There is as yet no evidence in support of the uniform Pleistocene glaciation on the Tibetan plateau that Trinkler (Geographische Forschungen im westlichen Zentralasien und Karakorum-Himalaya (Wissenschaftliche Ergebnisse der Dr. Trinklerschen Zentralasien-Expedition, Vol. 1). Berlin, 1932, pp. 20 and 75) assumed. The ice cover must have been sporadic and quite unlike that of the neighboring ranges.

heights of the cirques, which seems to correspond with either the plateau or the topmost terrace level. The farther extension of such old surfaces becomes more evident in the less glaciated portions of the range, such as near Muglib or towards the Pangur Tso, where

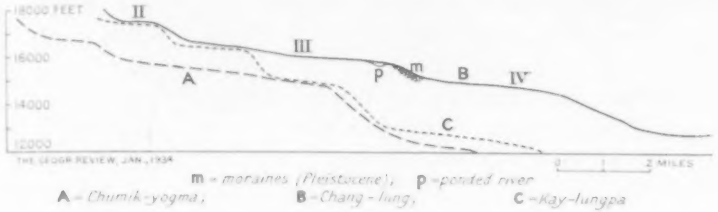

FIG. 20

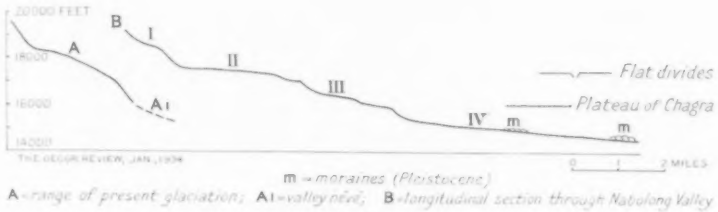

FIG. 21

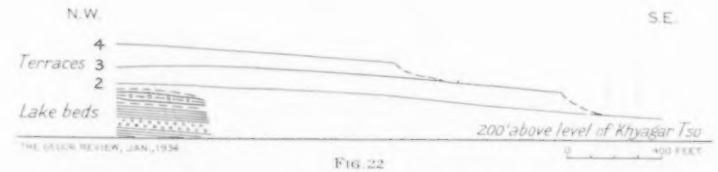

FIG. 22

FIG. 20—Longitudinal sections through present valley floors in the Ladak Range.
FIG. 21—Longitudinal section through the Nabolong Valley near Chagra. Smaller steps indicate halts of glacier retreat while larger ones are slopes between erosion levels.
FIG. 22—Tilting of young Pleistocene lake terraces and lake beds on west shore of Khyagar Tso, Rupshu. Vertical scale exaggerated ten times.

level-topped spurs are seen to project from both flanks of the Panggong Range at similar heights.

The Ladak Range on the south gives excellent examples of a pre-glacial mature relief. On its northern flank we see around the Kaksang Pass at 17,450 feet a rolling surface with valleys one to two miles in width separated from one another by low divides. Small rivulets locally dammed up or ponded meander through the morainic filling. Farther northwest one observes the same spectacle (Fig. 20)—the headwaters moving sluggishly around sand bars until they break through the terminal-moraine walls and fall at a rate of 1600 feet per mile through boulder-choked gorges down to the junction with a Shayok tributary. The southwestern slope of the same range exhibits a higher spur level at 18,430 feet and a lower one at about 16,700 feet,

the former presumably the plateau level, and the other a dissected continuation of either level I or level II. Both old surfaces can be followed over a distance of almost 100 miles along the Indus Valley, where they seem best preserved around the Chang La (Fig. 10). Here they actually give the impression of greatly elevated plateau remnants, and their position above the glacial relief becomes once more apparent. Their former extension across the entire eastern Karakoram is, therefore, reasonably established.

If one takes into account a certain amount of glacial and postglacial erosion, the mean slope of the mature relief is hardly perceptible in this direction for a distance of 90 miles from the present edge of the west Tibetan plateau. The fact that no higher level than 16,700 feet is discernible on the southern flank of the Ladak Range might be explained by the stronger effects of Pleistocene glaciation and denudation along the Indus Valley. If this were the case, we should expect to find the equivalent morphologic units of the mature relief on the opposite side of the Indus, in the Zanskar and adjoining ranges. In reality, none of the remnants of this mature relief within the northern Himalayas ever reach the height of the west Tibetan plateau and its terrace level (I).

The most elevated plateau remnant in Rupshu—also known as "Chang-tang" (great plain)—lies between the Puga River and Lake Khyagar at an elevation of 16,600 feet (Fig. 9). A corresponding remnant occupies the northern slope of the Zanskar Range south of Mahe, at a slightly higher level—an average of 17,000 feet (Fig. 5). Such mature and late-mature forms make patches of rolling surfaces 200 square miles in extent. Their valleys show the effects of glaciation. Along the higher mountains we recognize rows of truncated spurs where the upper valleys have their outlets to the plateaus.[33] The area occupied by the mature relief is enormous, extending far into Tibet and thence south to the central crest of the Himalayas,[34] while toward the northwest we can follow it across Ladak into Baltistan.[35]

The question arises whether all these remnants of a late-mature relief belong to one uniform stage of erosion or whether they represent various phases. The existence of remnants of flat surfaces at two levels in the northern Himalayas, namely Nari Khorsum (15,000 feet) and Deosai (12,500 feet), the latter of which extends clear across the central Himalayas more than 80 miles southward to the Pir Panjal Range in Kashmir, indicates both an earlier and a later cycle of erosion. And such is also the case in the eastern Karakoram.

[33] On Pleistocene glaciation in Rupshu and neighboring regions see Giotto Dainelli: Studi sul glaciale (Relazioni Scientifiche della Spedizione Italiana De Filippi, nell'Himàlaia, Caracorùm e Turchestàn Cinese (1913–1914), Ser. 2, Vol. 3), text and atlas, Bologna, 1922.

[34] L. R. Wager: The Rise of the Himalaya, *Nature*, Vol. 132, 1933, p. 28.

[35] Karl Oestreich: Die Täler des nordwestlichen Himalaya, *Petermanns Mitt. Ergänzungsheft No. 155*, 1906.

Intermediate Mountain Groups and Lower Levels of Erosion

Apart from the graded lower slopes of the main ranges, there are mountainous regions where dissection, Pleistocene or recent, has led to a more youthful relief. Such are the Karakoram-Lingzi-tang Range and the regions south of Chushul, north of Lake Panggong, and around Tso Moriri. Here the effects of Pleistocene valley glaciation

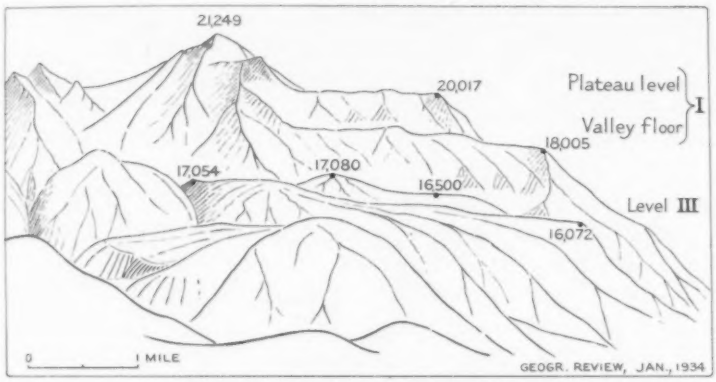

Fig. 23—Terraces on northern slope of Chang-chenmo Range near Pamzal. Altitudes by trigonmetrical determinations. Compare with Figure 13.

become dominant features. Along the lake basins or the larger rivers vigorous postglacial river action has cut V-shaped valleys or gorges on the floors of the wide flat valleys. But where the Indus drainage with its rejuvenating influence has not yet reached the more remote areas, as in the upper Chang-chenmo or Mitpal valleys, the change from a glacial to an arid subarctic climate (post-Pleistocene) has resulted in forms typical of drainless regions—wide, basin-like valleys with heavy accumulations of sediment (Figs. 7 and 25) and smaller basins with salt lakes. As formerly mentioned, these intermontane basins are features inherited from the young Tertiary relief, but their present shape is the result partly of glacial and partly of subrecent erosion.

Two features within this unit deserve special attention—the uniform appearance of the stepped stream profiles and their correlation with isolated occurrences of older surface forms. In the Chang-chenmo Range, for example, one notices on the northern slope (Figs. 13 and 23) at 16,500 feet a distinct terrace that might be taken for the shoulder of the greatest Pleistocene Chang-chenmo glacier. South of the same range, however, a similar level appears (Fig. 20) in all the valleys where younger erosion has not yet altered or destroyed the older land forms. A step in the valley gradient, sometimes of as much as 1000 feet, separates this level III from level II, its concave shape being often obscured by terminal-moraine walls. This feature

repeats itself at a lower point where the moraine wall forms spectacular boulder "cascades," such as in the Nabolong Valley near Chagra (Figs. 20 and 21). Here the moraine wall encircles a lake on the upstream side, while downstream it falls abruptly to the next lower valley floor. Elsewhere (upper Chumik-yogma) the moraines have been washed away, and the step becomes visible in bed rock. This interrelation between valley step, terminal moraine, and lake is also a characteristic feature in the Ladak Range, where again a level between 16,000 and 17,000 feet and a lower one between 15,000 and 16,000 feet (IV) are uniformly developed (Fig. 20). As described in a former case (p. 31), the various valley levels may be followed across the intermediate country, where they give rise to even ridge levels or terraces. Not only do they occur in glaciated valleys but such surfaces continue over an entire mountain group. North of Panggong and especially around Chagra they shape the contours, appearing as broad spurs and flat divides (Fig. 24).

The steps in stream profile thus separate levels of former river action. Here they are not the result of successive stages of glaciation, as is the case in the alpine valleys of Europe and America. Their age relationship to the higher surface forms can be determined to a certain degree by interglacial lake deposits or by terminal moraines that cover the valley floors. By comparison with the interglacial strata from the Indus Valley and Panggong described by Dainelli[36] these lake deposits may reasonably be attributed to the last interglacial (Riss-Würm) age. At that time large bodies of fresh water formed all over the region. In the higher valleys these were dammed up, and plant-bearing clays were deposited in them. The flat valley floors must then have been already in existence; in fact, they must date back to an earlier interglacial period when river action was temporarily set free. The fact that a new level of erosion was formed that is distinctly independent of ice action leads to the assumption of an interglacial uplift. The terminal moraines of the last glaciation, lying on top of the lower level IV, point to a second phase of interglacial river action. In some instances it can be shown that this level was not entirely covered by ice. Another short uplift seems to have occurred, which produced the larger steps in the valley gradient.

Traces of similar surfaces of erosion lower than the highest Changtang level are frequently met with in the northern Himalayas. A high terrace at 15,600 feet is to be seen on both flanks of the range that lies south of the Indus between Kalatze and Leh. The Deosai plateau[37] is another level of this kind. In these regions later erosion has destroyed most of the older physiography so that it is almost impossible to assign any of the recognizable levels to definite periods

[36] *Op. cit.*

[37] Oestreich, *op. cit.*, pp. 81–89.

FIG. 24

FIG. 25

FIG. 26

FIG. 24—Old relief north of Panggong near Chagra. Panggong Range in background.

FIG. 25—Old drainage channel of Chang-chenmo on the west Tibetan plateau, modified by Pleistocene glaciation and subsequent arid weathering in drainless region. View from ridge near Shum eastward.

FIG. 26—Former valley of the Shayok-Harong River between Tangtse and Durbuk. In background Panggong Range toward Shakya La.

within the Pleistocene or younger Tertiary. Their correlation with the terraces and plateau levels previously mentioned is made uncertain by the fact that the Zanskar Range has suffered from recent tilting through uplift. Proof of such post-Pleistocene movements is to be found in the tilting of lake deposits around Khyagar Tso in Rupshu (Fig. 22). Whatever the relationships of the individual erosion levels between the Himalaya and Karakoram may be, one important fact remains: both mountain ranges show residuals the highest of which antedate the glacial cycle of erosion. They are piedmont levels on a gigantic scale, ranging in altitude between 15,000 and 20,000 feet within the Karakoram and between 12,000 and 16,000 feet in the northwestern Himalaya. Although greatly altered by glaciation, Pleistocene and present, as well as by recent rejuvenation, such older land forms give the present physiography a definite set of inherited characteristics. Before further conclusions can be drawn, brief consideration must be given to the drainage of this older relief.

Main Drainage Channels of the Preglacial Relief

The more important rivers of the Karakoram, such as the Indus, Shayok, Nubra, and Chang-chenmo, follow the strike of the ranges, and their valleys lie on major fault lines. Where they have abandoned their former channels, these will be found to continue in the geological trend. In only one instance does the Shayok cut through the range at its great bend at about 78° 15′ E. The longitudinal drainage of the Karakoram, one of its salient physiographic features, contrasts with the transverse drainage of the southern and central Himalaya. The ancient character of this pattern becomes clearer as we try to eliminate its secondary attributes, such as transverse cutting or capturing by the Indus (Fig. 27).

Beginning with the Lingzi-tang in the north, various headwaters drain the eastern slope of the Karakoram-Lingzi-tang mountains west of Taldat (Fig. 6). They now end in lakes, but, as Trinkler has pointed out,[38] the headwater rivers must have been larger before the present arid cycle. Lingzi-tang and the Sumdjiling plain during part of the Pleistocene were occupied by a single lake and must previously have formed one continuous valley, in which a river flowed from west to east, leaving deposits (p. 32) that permit the tracing of its former course. Although it is obvious that the great width of these elevated plains (10–20 miles) is not exclusively the work of river action, it becomes evident that the former rivers meandered through wide valleys. The fact that Pleistocene and Tertiary lake and fluvial strata occur only along these longitudinal drainage lines indicates that the older drainage of western Tibet was directed from west to

[38] Geographische Forschungen, pp. 18 ff.

east, following the axes of the ranges at a period when the relief was late mature or old.

The Chang-chenmo also flowed across this surface. Its valley width, disproportionate to the shallow flood channel, suggests an old connection with the upper Shayok at a time when the latter had not yet cut through the main Karakoram range. This Shayok-Chang-chenmo stream faithfully followed the reëntrant of the ranges by bending eastward to continue across Lanak La into Tibet. Here its former easterly course can be detected likewise through the occurrence of preglacial fluvial deposits (Figs. 7 and 25). As in the case of the Lingzi-tang, this river left behind wide valley plains, remnants of which, according to Huntington,[39] have survived even the younger dissection in the upper Shayok region. The main tributaries were the Kugrang and Rimdi rivers, which still join the stream at acute angles in the original west to east direction. The former now constitutes the source of the Chang-chenmo.

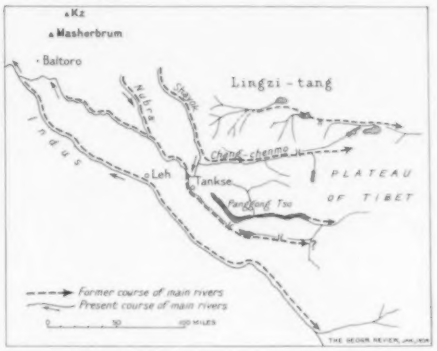

FIG. 27—Preglacial (young Tertiary) drainage pattern of eastern Karakoram.

The third main drainage channel lay in the great depression between the Chang-chenmo and Panggong ranges (Fig. 26). It followed the Nubra, Shayok, Tangtse, and Harong valleys and continued via Chushul-Pangur Tso to the Nyak Tso. The old valley floor is poorly preserved, but it may still be traced along the Harong Valley toward Pangur. Like the Shayok-Chang-chenmo, it drained the high culmination of the Karakoram (Fig. 27), first in a northwest-southeast direction (with the lower Shayok as a tributary), then west-east, parallel to the trend of the ranges. Near Tangtse (Fig 26) its old course is visible in the large outlet of the Harong Valley, while the gorge toward Muglib is distinctly younger in origin. Possibly this stream pursued its course via the Tsaka La (15,268 feet), although I consider likelier an eastward course through the Pangur depression. That the Panggong basin ever contained a large preglacial stream is doubtful. Being of *graben* structure, it probably had its individual drainage, which followed the eastward slope into Tibet. During the Ice Age it was subject to powerful glaciation,[40] and its outlet during interglacial times led to Tangtse and to the Shayok Valley.

[39] Ellsworth Huntington: The Pulse of Asia, Boston and New York, 1907, pp. 78–79.

[40] Ellsworth Huntington: Pangong: A Glacial Lake in the Tibetan Plateau, *Journ. of Geol.*, Vol. 14, 1906, pp. 599–617.

The Indus belonged in part to a fourth ancient drainage line. Its source may have been in the headwaters region of the Hunza and Gilgit rivers near where the Karakoram bends westward to merge with the Hindu Kush. Oestreich[41] recognized that its old course must have developed on the Himalayan "peneplain-level"—a term that suggests association with our mature relief in Rupshu. The peculiar short deflection of its course that takes place east of Nyoma is not a transverse valley but merely a bend following the reëntrant of the Ladak Range. Its preglacial valley floor must have been at the level of the previously mentioned flat spurs, which now are 3000 to 4000 feet above the valley (Fig. 8).

The preglacial drainage of the Karakoram then consisted of several subsequent rivers, many of which can be traced across an eastward-sloping relief that was interrupted by subsequent valleys developed along the strike of softer strata.[42] These rivers presumably extended across Tibet, the present topography of which provides sufficient evidence of an old west-east drainage under structural control. The headwaters of the Indus may then have followed the depression that is at present occupied by the upper Tsang Po (Brahmaputra), thus forming a giant artery of this subsequent river system that may have drained off through the meridional valleys of eastern Tibet and Sechuan. Even now the catchment area of the Brahmaputra extends across the entire southern Tibetan plateau.[43] Oldham's hypothetical suggestion[44] that the longitudinal valleys of the northern Himalayas antedate the origin of the transverse drainage seems well supported. The initial drainage was directed from northwest to southeast and east and not from north to south, as Oestreich[45] had suggested. Neither antecedence nor superposition[46] can be claimed for any of the rivers under discussion. A definite solution of this problem, however, must be left to a later date when all the geological and biological results of the Yale North India Expedition are available. There is already some reason to believe that the biological studies of Mr. G. E. Hutchinson on the origin of the endemic freshwater fauna in eastern Ladak will lend weighty support to the foregoing conclusions.

From the existence of a widely extended relief of late maturity or old age in our area we may conclude that the Karakoram and the Himalayas could not have been greatly elevated during late Tertiary time. Their present position is due to uplift, and its three successive

[41] *Op. cit.*, p. 103.

[42] Elsewhere (Geologische Forschungen, p. 118) I have called attention to the eastward pitch of the Karakoram axis of folding and the coincidence of its highest point of elevation with the virgation and topographic culmination around K_2.

[43] Burrard and Hayden, *op. cit.*, Part 3, Chart 23.

[44] R. D. Oldham: A Manual of the Geology of India, 2nd edit., Calcutta, 1893, p. 463.

[45] *Op. cit.*, p. 105.

[46] *Ibid.*, p. 106.

78°00'
78°30'
34° 00'
33° 30'
Shayok River
Digar
Digar La
Chang-chenmo
Koh La
(Ororotse La)
Ororotse Tso
Shakye La
Hebuk La
Durbuk
Tangtse
Moreb
Brarsi Tso
Kak-lungpa
Chagra
Marsimik La
Spangmik
Man
PANGGONG TSO
Mirak
Hemis Monastery
HEMIS
Ugu
Upshi
INDUS RIVER
Gya
Kar-tse
Rum-tse
Khum Jungpa
Taglang-la
TAGLANG
Shing-puk La
Shakung
KIMNE
RUKCHEN
Kar Tso
Stu-rkha-puk Tso
Puga River
PUGA
Mahe
Puga
Kyoma Rap
Kak-Steg La
Kak-dong La
Pialung

79°00'
79°30'
34°00'
33°30'
Kyam
Kyangri
Chungang La
Sha Thrao
Tog lung Marpo
Chang Lamma
Drogpo Karpo
Chume Lang
Nyagtsu
Throb-ding La
Kiu La
Ane La
Chang Lung
Pangur Tso
Rezang La
Kegrang Lungpa
Teeba Lungpa
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THE YALE NORTH INDIA EXPEDITION, 1932

THE EASTERN KARAKORAM AND ZANSKAR-HIMALAYA BETWEEN THE CHANG-CHENMO AND TSO MORIRI

Surveyed by

KHAN SAHIB AFRAZ GUL KHAN, SURVEY OF INDIA

Courtesy of the Surveyor General of India

Scale 1 inch to 8 miles or 1:506,880

0 5 10 20 30 40 50 Miles

(Scale of original survey, 1 inch to 2 miles)

Snow — *Areas under permanent cultivation*

Glaciers — *Lake soundings by G. E. Hutchinson*

Passes — *Earlier soundings*

Settlements — *Route of expedition*

Elevations in feet *Contour interval 500 feet*

levels below the oldest valley floors of the plateau point, in conjunction with geological facts,[47] to repeated phases of epeirogenic upheaval.

The physiographic evolution of the relief may be summarized thus:

1. Young Tertiary relief of post-mature or old development. Monadnocks and lower ranges surmount an undulating surface (plateau level and old valley floors, level I).
2. Uplift and dissection followed by carving of mature forms at a lower level (II).
3. First Pleistocene ice advance remodels earlier relief.
4. During earlier interglacial period uplift and formation of level III, which was subsequently covered by deposits of later interglacial.
5. Maximum glaciation, most powerful in old drainage channels.
6. Later interglacial (Riss-Würm) and uplift. Establishment of level IV; period of large fresh-water lakes.
7. Last ice advance (Würm period).
8. Recent uplift and post-Pleistocene rejuvenation, particularly effective along the Indus drainage. Also local tilting of terraces and of lake deposits in the northern Himalayas (Rupshu).

The high elevation of the surveyed region and very likely that of the neighboring ranges are, therefore, due to late Tertiary and Pleistocene uplift and not to folding. Whether such uplifts resulted from isostatic adjustment, as Wager[48] seems to think, remains an open question until more detailed gravimetric surveys are available from both the Himalayas and the Karakoram.

[47] The Siwalik boulder conglomerate in the Himalayan foothills indicates a first uplift in the later Pliocene; unconformities between old and younger Pleistocene in Kashmir and the Punjab, a second movement. A third one is proved through unconformities between young Pleistocene and recent strata in Kashmir and Rupshu.

[48] *Op. cit.*

WHITE SETTLEMENT IN SABA ISLAND, DUTCH WEST INDIES

A. Grenfell Price

THOSE nations that are still attempting white settlement in the tropics may well consider the case of Saba Island. The white inhabitants of this tiny member of the Leeward Islands form one of the very few groups of peoples of northwestern European descent that have conducted a long-standing tropical settlement with success.

Saba is a young volcanic island,[1] some five square miles in area, fertile and verdure-clad, a tangle of rugged hills that rise by steep slopes or sheer cliffs to a cloud-capped mountain peak 2887 feet above the sea.[2]

Early History

The early history of white settlement in Saba is obscure, owing to the fact that this island and its neighbor, St. Eustatius (Statia), were first settled by private individuals under concessions from the Dutch West Indies Company, which did not appoint a governor until 1671 nor repurchase the rights of the proprietors until 1682. It is known that the Dutch colonized Statia in 1636,[3] after an attempt by the French under Du Cusac had failed through lack of water—a lack that the Dutch remedied by building cisterns such as those that form so prominent a feature in Saba and Statia today. César de Rochefort in his "Histoire Naturelle et Morale des Iles Antilles de l'Amerique"[4] observes that Saba was thought to be merely a rock until the colony of St. Eustatius sent people to it. These found "a pleasant valley and enough good land to occupy several families, who live contentedly in this kindly retreat."

Island legend tells that planters from Statia first settled the "Windwardside" as a sugar and coffee plantation. Old inhabitants still point out the remains of an alleged sugar refinery on the eastern shore. Hamelberg says that, according to tradition, the earliest colonists took possession of the south of Saba, where they built a fort and a village on the present "Fort Bay." However, they soon experienced the geographical difficulties of the island, for one of the frequent cliff slides demolished the fort and houses, and several of the people were killed. Later inhabitants turned this same geographical

[1] W. M. Davis: The Lesser Antilles, *Amer. Geogr. Soc. Map of Hispanic America Publ. No. 2*, 1926, pp. 35–36.

[2] West Indies Pilot, Vol. 2, *U. S. Hydrogr. Office Publ. No. 129*, 4th edit., Washington, 1929, p. 123. Earlier editions give the altitude as 2820 feet.

[3] J. H. J. Hamelberg: De Nederlanders op de West-Indische Eilanden, Narrative and Documents, Amsterdam, 1903, Narr., p. 18.

[4] Rotterdam, 1658, p. 43.

factor to their own advantage when they defeated a French attack by rolling rocks on the heads of the invaders in 1688–1689.

The English captured Saba in 1665 and held it until 1667. They again took the island in 1672 and, although they nominally restored

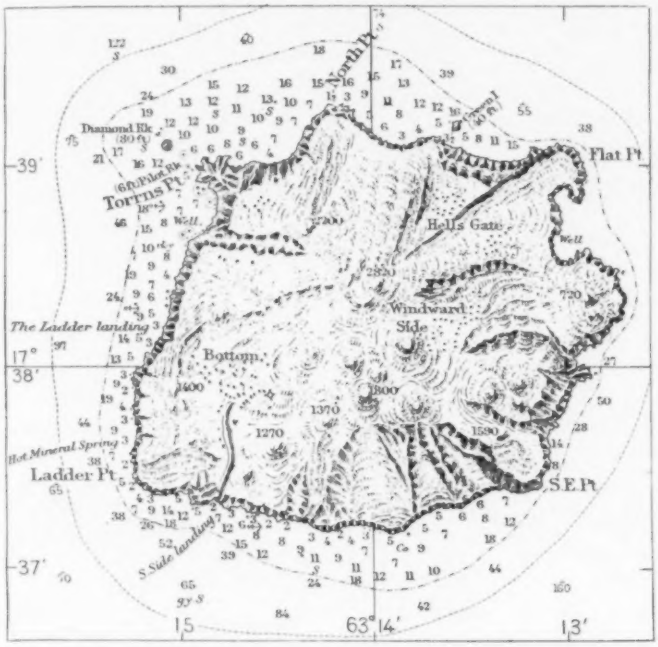

FIG. 1—Saba Island (from U. S. Hydrographic Office Chart No. 1011, 1914). A later figure, West Indies Pilot (4th edit., 1929), gives the altitude of the culminating peak as 2887 feet.

it in 1674, continued to administer it for eight more years. These English occupations and the sea interests of the islanders probably account for the fact that Saba remains English-speaking today. Hamelberg makes it clear that when the English captured Saba in 1665 the island was inhabited by a variety of races and that some of the people were probably planters employing negro slaves. The records state that there were 87 Hollanders and 54 English, Scots, and Irish, with 85 negroes and Indians, and that the English sent the defeated Dutch settlers to the island of St. Martin. During the second British occupation the governor of St. Kitts and Nevis, William Stapleton, said that he wished that Statia and Saba were sunk to their own height in the ocean, as their inhabitants gave so much trouble by smuggling. It is thus fairly certain that during the latter half of the seventeenth century the Saban community consisted of small planters and seafarers—the latter engaged in more or less legitimate vocations.

Father Labat, who visited the island in April, 1701, paints a very

FIG. 2

FIG. 3

FIG. 4

FIG. 2—Fort Bay, the landing on the south coast of Saba Island.
FIG. 3—The cliffs of Marypoint.
FIG. 4—Ladder Bay, the landing on the west coast of Saba; "ladder" on the left.

FIG. 5

FIG. 6

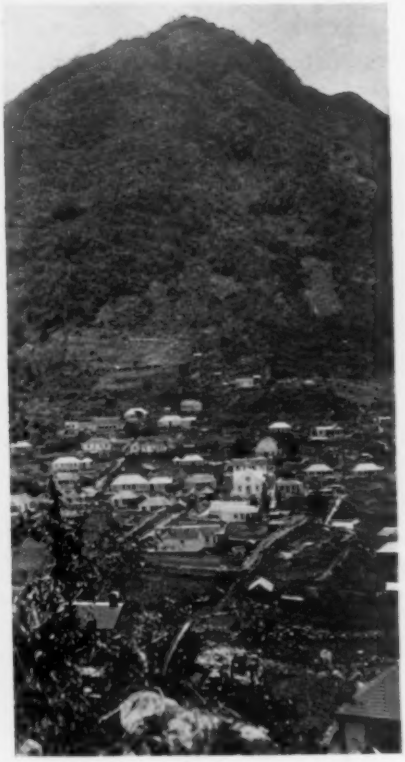

FIG. 7

FIG. 5—A white agriculturalist amongst the tree fern at 2000 feet.
FIG. 6—Bananas and tree ferns in the crater at the top of the mountain. About 2700 feet.
FIG. 7—Windwardside. The mountain with agricultural clearings in the background.

favorable picture of a prosperous little planting community.[5] The island, he states, was practically inaccessible, except at the present Fort Bay landing, where a zigzag pathway ascending to what is now the Bottom was defended by piles of rock balanced on planks in such a way that the inhabitants could dislodge them easily. The village of Bottom, situated in the midst of level and fertile ground, was laid out in two quarters, containing 45 to 50 families. The dwellings were nicely painted white and were dry, comfortable, and neat. Almost all the inhabitants, including the commander, practiced shoemaking, and shoes and a little indigo and cotton were the only exports. Labat thought them rich in their possessions, which included slaves, silver, and fine furniture.

Abbé Raynal gave another happy description of Saba almost a century later.[6] He said that in the island plants grew to an extraordinary size. Fifty European families with some 150 slaves raised garden produce and cotton. The latter they wove into stockings, for which they obtained very high prices in the other colonies. Throughout America there was no blood so pure as the Saban: the women preserved a freshness of complexion that was not found in any other of the Caribbean islands.

Meager as are the historical records, the important point is that they include the names of some of the present white families at a very early date. In 1672, for instance, the English appointed a John Hassell as one of a council of three persons to administer Statia, and it is probably the same family name that appears as Hazel and Hasselie, the former in a list of Saba and Statia residents in 1687–1688, the latter in the papers of Saba and Statia, 1698–1703. We found members of the Hassell family who still pronounce their name as Hazel. The list of 1687–1688 contains also the names of Van de Poele, Simons, and Heyliger and notes that a Simons and a Van de Poele were living in Saba at the time. Hamelberg also shows that in 1687–1689 a Zeegers and a Piertsz were officially connected with Saba, while a Jacob Leverock appears as governor of Saba at the end of the seventeenth century. Thus it seems fairly certain that by 1700 at the latest most of the leading Saban families were already residing in the island or in near-by Statia.

Access to the Island and Its Villages

Little that is authentic has been written about Saba, for all communications were by small and uncomfortable schooners until two or three years ago, when the Dutch government subsidized a passenger

[5] J. B. Labat: Nouveau voyage aux isles de l'Amerique . . . . The Hague, 1724. Vol. 5, pp. 341–345.

[6] G. T. Raynal: A Philosophical and Political History of the Settlements and Trade of the Europeans in the East and West Indies (translated by J. O. Justamond), Dublin, 1784, Vol. 4, pp. 250–251.

and cargo service by a small steamer of the Royal Dutch Netherlands Company. The vessel runs fortnightly from Curaçao (the seat of the governor of the Dutch West Indies) to Bonaire, St. Thomas, St. Martin (seat of the subgovernor of the northern islands), Saba, Statia, and St. Kitts and back via Statia, Saba, St. Martin, and Bonaire to Curaçao. Sensational writers have done some harm to Saba by absurd exaggerations of the difficulties of access. In point of fact, the inhabitants keep small boats at no less than four landing places, and one or the other of the two regular landings at Fort Bay in the south and Ladder Bay in the west is so safe in every wind that only one fatal accident has been recorded in historical times. From the two main landings excellent stone and concrete paths and stairways lead to the village of Bottom. The Fort Bay track is the easier for porters and donkeys and is used except when seas are raging into the bay under southerly winds.

Inaccurate statements are frequently made that the islanders build large vessels on the top of the cliffs and "lower them 2000 feet by ropes" or "shoot them over into the sea below." We found all construction of schooners carried out on the shore line. However, no suitable place exists at Well Bay, south of Torrens Point, as the West Indies Pilot says, and it is probable that the inhabitants are correct in their statement that the old shipbuilding center was Tent Bay on the south coast, a spot once connected by path with Fort Bay. In former times the white Sabans were expert carpenters and shipwrights, but few schooners have been constructed since emancipation, for it has proved cheaper to import suitable craft from such places as Gloucester, Mass. The early Sabans used their slaves to cut hardwood timber on the Saba mountain, the Quill of Statia, and on other Caribbean islands. The present inhabitants still construct small boats in their villages as high up as Windwardside (1400 feet), and porters, mainly colored, lug them down to the beach.

The ascent to Bottom may be made on foot, by horse, or in a chair borne by negroes. All the paths are too steep for wheeled vehicles. The donkeys, a recent importation, are still somewhat unpopular on the ground that they have caused unemployment. Porters still handle the heaviest "buns" or parcels. Every plank of building material and every piece of furniture has been lugged up the cliffs by human labor, even such articles as pianos.

The Villages

The village of Bottom, unofficially called Leverocktown after a former governor, lies in a circular basin about a mile in circumference. It numbers 436 inhabitants. Commanding the two chief landings, it still remains the seat of government, although it is overwhelmingly

black and is smaller than Windwardside. The administration is conducted by a receiver with the aid of a few officials such as a doctor, customs officer, and postmaster. Five policemen and an annual deficit form an adequate defense. Crime is astonishingly rare. The customs duties are very low, and the happy island now has no income nor land taxes, as the latter proved too small and expensive to collect.

FIG. 8—The village of Bottom (The Bottom, The Bottoms) and the Ladder Bay gap which has such a marked effect on climate.

The Netherlands government loses money in helping the inhabitants, who, like those of many isolated communities, seem inclined to accept spoon feeding and grumble that the oversea taxpayers should provide even larger sums. Dutch, the official language, is taught in all the schools, but the people use a debased form of English of limited vocabulary and characteristically spoken in a high singsong voice. The island has Roman Catholic, Anglican, and Methodist churches, and there are three government and two Roman Catholic schools. There is a small public library, but the inhabitants, government, and churches have so far failed to establish any institute or adult educational society. The authorities have recently installed a wireless station, but those responsible should make some effort to mitigate isolation by increasing the miserably inadequate supply of world news. There are a few private wireless sets, but, as there are no garages and no mechanics in Saba, the maintenance of batteries is a problem.

The Receiver offers the utmost kindness, help, and consideration. There are several boarding houses in Windwardside and Bottom, and, with special permission, very comfortable accommodations can be obtained at the Government Guest House.[7]

[7] The writer is deeply indebted to the Governor of Curaçao and the Subgovernor of St. Martin for their assistance, and he would acknowledge particularly the help given by Mr. Willem de Brauw, Receiver of Saba, in furnishing accommodations, means of transport, and statistics, and by Mrs. de Brauw in translating Dutch documents.

From Bottom an excellent stone and concrete path leads to the chief cliff settlement of Windwardside. Rough but passable tracks also connect Bottom with Marypoint and Windwardside with St. John and with Zion Hill, more popularly known as Hellsgate. The main pathway rises abruptly from Bottom to the crest of the southern slope of the island, where a small cluster of houses bears the name

FIG. 9—Windwardside and Booby Hill with its agricultural land

of Crespin, in tribute to the shoemaking of Father Labat's day. Leaving the village of St. John to the west, the path winds along steep slopes and cliffs, which rear up from a gloriously blue sea more than a thousand feet below. At every turn the traveler is rewarded by magnificent views of crag and verdure or of the islands of Statia, St. Kitts, and Nevis—three great peaks that overlap one another in the ocean to the east.

Windwardside, the largest village of the island, is situated partly on the eastern slope of the mountain and partly on a neck of land connecting the mountain with Booby Hill, whose flat top furnishes excellent agricultural land. The village contains 511 people, with whites still predominating. Its altitude is about 1400 feet. Hellsgate, a mile or so to the north and 200 feet higher, contains 231 inhabitants, almost all of whom are white. St. John (1200 feet) has 229 people, white and black.

The cliff villages are picturesque, clean, and well kept, like most of those in the Dutch possessions. The pretty little wooden houses are for the most part painted white, with green or brown shutters and red roofs. They average four or five small rooms but often contain as many as eight or nine. The Sabans use very substantial frames of hard wood set in firm foundations. They reënforce their buildings wherever possible and guard all windows with solid wooden shutters

as protection against hurricanes. Most of the houses stand in small plots, which are kept spotlessly clean and are often cemented and which, like the narrow, winding, but well kept streets, are bounded by stone walls. These last, when of cut stone or fine masonry, usually date back to the slave days. From most roofs wooden gutters carry the water to one or more cisterns, though some cisterns are supplied from the concrete yards that surround the greater number of the houses. These reservoirs are of immense value. There are more than 250 of them in Saba, and shares in them pass by will. Nearly all the houses of the whites have pit privies, which seem fairly satisfactory. A very unusual and objectionable feature, however, is the number of "back-yard" graves. One old gentleman emerged from his front door and pointed with pride to a very large concrete cistern at one end of his veranda and to an almost equally large concrete cylinder at the other—his father's and mother's grave. The churches are doing their utmost to prevent this type of burial, but here and in the compulsory construction of privies it is for the government to take a stronger line. The people rarely keep their coffins in their parlors, as has been depicted, but, owing to the shortage of timber, some of them import the wood in happy anticipation. We found one case where two coffins were constructed and kept under the family bed for many years.

The Climate

Despite the rhapsodies of visitors, the climate of Bottom is distinctly tropical, as the elevation is only 800 feet. Conditions are, however, ameliorated by the winds, which blow almost constantly through the Fort Bay and Ladder Bay gaps on the south and west, although neither gap is more than a few hundred feet in width. Also, the towering mountain on the east and the hills on the west lessen the hours of tropical sunshine, it has been estimated, as many as four hours a day. The government keeps no record of wind or humidity but reads the temperatures in Bottom at 7.45 a. m. and 1.45 and 3 p. m., while the Royal Dutch Meteorological Institute publishes somewhat irregularly rainfall figures for Bottom, Windwardside, and St. John.

The figures indicate just such rainfall variations as one would anticipate. Bottom, 800 feet above the sea and in the southwestern rain shadow, had an annual average of 1047 millimeters in the thirteen recorded years between 1919 and 1932. St. John, 1200 feet and in the same rain shadow, had 1060 millimeters in seven recorded years, and Windwardside, 1400 feet, on the northeast, and in the trade winds, had 1126 millimeters in eight recorded years. No doubt the agricultural village of Hellsgate, at an elevation of 1600 feet and even more in the trades, would show a still higher rainfall, and the

FIG. 10

FIG. 11

FIG. 12

FIG. 10—Street in Bottom. Government buildings on left.

FIG. 11—Typical "white" house of slave days with ornamental gate posts, cistern (left front) and privy.

FIG. 12—In Windwardside. Grave in foreground; water cistern between it and the house.

summit of the mountain, which is almost always clouded, considerably more. Throughout the island the heaviest rains occur in the period September to December, but there is usually some rain during every month of the year.

We were told by the Receiver that the temperatures in Bottom usually vary from an average of 22° to 27° C. (71.6° to 80.6° F.)—temperatures distinctly of the tropical coast lands, as may be seen by comparison with figures for Basseterre, St. Kitts, situated some 40 miles from Saba at an elevation of 157 feet (both sets of figures for 1930).

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Bottom													
7.45 a.m.	73.9	74.5	75.0	78.0	79.9	80.6	80.2	82.2	82.2	82.2	79.3	78.2	78.9
1.45 p.m.	82.4	84.2	85.8	87.5	88.0	88.7	89.0	91.4	91.8	92.9	89.8	86.6	88.2
Basseterre													
Mean	74.1	75.3	76.7	79.2	80.9	81.9	81.2	80.7	81.2	81.1	79.0	78.5	79.1

Profuse perspiration follows any exercise and indicates that the humidity is great. The climate is undoubtedly better in the cliff villages, but even in these the air is hot and the humidity clearly high. We found that it was by no means cold at the summit of the mountain (2887 feet) on a rainy and cloudy day.

Slave-Owning and Sailing-Vessel Days

At first glance Saba seems to provide some splendid climatological data for those who emphasize the importance of climate on white settlement in the tropics. Bottom (800 feet) has become almost entirely black. Windwardside and St. John (1200 to 1400 feet) are partly white and partly colored. Hellsgate (1600 feet) is almost entirely white. Marypoint (about 1000 feet) is white but decadent. Unfortunately one dare not accept a simple climatic explanation. Even these small settlements illustrate the complex factors influencing white people in the tropics.

The village of Bottom remained the seat of many prosperous white families until some time after the slave-owning and sailing-vessel days. In the nineteenth century the Simmons, Leverocks, Vantepools, Winfields, and other families occupied the village and owned neat, well built houses, the adjacent agricultural holdings, slaves, and schooners, which carried on a great deal of the trade of the Caribbean and provided each almost self-supporting household with the few outside commodities required. Schooling was given to family groups by educated Sabans or by schoolmasters engaged from St. Thomas or from other islands. One of the natives taught navigation for many

years. At maturity many of the boys went to sea on the family vessels. Sabans did much of the gun running in the Central and South American revolutions, and old inhabitants still remember when numerous schooners were owned and were running from Leverocktown.

In those days the inhabitants of Bottom considered themselves the *élite* of the island. They married only in their village or with a few newcomers, such as the children of clergy or doctors. A resident of more than eighty years told us that he remembered only two weddings between people of Bottom and Windwardside. Throughout the island the whites in past years seem to have maintained a very fair standard of morality and close adherence to the color bar. In 1861 only three white births out of a total of 23 were illegitimate, and tradition holds that the first white woman to bear a colored child was burned alive.

Extraordinary statements have been made to the effect that all the inhabitants of Bottom are Simmonses and that only Hassells are found in Windwardside. We have already shown that the early records contain at least seven family names. Several more appear in the oldest government documents preserved in Saba (from 1852 on), and the list of slave owners compiled for the emancipation of 1863 gives some eighteen different names. The last census (1932) made no color distinctions, as is the Dutch policy, but it seems that there are now some twenty white-family names.

Although the paucity of names in Saba has been exaggerated, inbreeding has been considerable, due particularly to the isolation and local spirit of the villages—a usual feature in mountainous country where difficulties of communication are great. This intermarriage is clearly shown by the records preserved in old Bibles and by the official list of white marriages from 1852 to 1863, when records cease to make the distinction. It is small wonder that in a total population of 1449 there are today 292 Hassells, 149 Johnsons, 95 Simmonses, 58 Sagors, and 52 Everys. Yet, except in the tiny village of Marypoint, inbreeding does not seem to have destroyed fertility, stamina, or ability. Families of eight or more children were common in the nineteenth century. From 1852 to 1861 white births numbered 201 and deaths only 160, and many members of the oldest Saban families who left the island showed remarkable capability in the outside world.

Changes After 1860

Between 1860 and 1920 two blows ruined the white settlers of Bottom. The first, which also affected the whole island, was the action of the Dutch government, which in 1863 emancipated 700 slaves in Saba. Although the planters received generous compensation at the rate of 80 dollars per healthy negro, production became

less organized and labor more difficult to manage, and the introduction of the cash nexus was followed by a rise in wages to the present figure of 60 cents a day.

The second trouble was the change from sailing vessels to steam. About thirty years ago most of the energetic young men of Bottom and many from the cliff villages were drawn away by permanent inducements offered in New York and other headquarters of steamship companies and emigrated, often taking with them Saban wives. Then it was that the remarkable inherent qualities of these tropical whites became evident. Large numbers of the islanders secured positions as commanders and officers of important steamers. Others proved capable as harbor masters or pilots, and some made good in university positions and in business. We were given the almost incredible figures that during the Great War no less than 95 officers and one quartermaster of the United States navy were Saban born. Today quite a number of island men and women can be found in good social positions throughout the Caribbean. Several whom we met were of a very fine type and looked healthier than the people who had remained in the supposedly better climate of Saba. Diet, no doubt, does much to account for the difference. It is also possible that seafaring occupations are particularly favorable to whites in the tropics. The Cayman Islands, for example, produce some fine types. The point remains, however, that Bottom lost her slaves, schooners, and vigorous young people. Today the remnants of white population consist largely of aged persons.

White Agriculture

The whites of Windwardside and Hellsgate may be classed as small yeomanry or peasant farmers of a good class. As the number of slaves—men, women, and children—averaged only seven per proprietor at the emancipation, most of the whites must have worked beside their slaves. Many of the men of the present generation are at sea or are engaged in carpentry, wood polishing, and similar industries in the United States; but the remainder are almost all occupied with agriculture, cultivating the mountain side and small areas of fertile ground on spurs and elevations such as Booby Hill. Here they terrace almost incredibly rugged and steep slopes for bananas, yams, sweet potatoes, cassava, and temperate-zone vegetables, including excellent Irish potatoes. These last they sell in Curaçao. They also raise cattle, pigs, fowls, goats, and sheep: the sheep they use for meat and not for wool.

Up to 2000 feet bananas and vegetables are grown on laboriously terraced ground. Elephant and guinea grasses have been introduced and are fed to stock with success. About this altitude a belt of lovely

tree fern begins. It is typical of this strange island that the best bananas are grown far above even the temperate-zone vegetables, for some fifty years ago it was discovered that bananas throve astonishingly in the small crater hollows at the top of the mountain, where the soil is moist and exceedingly rich. Transport difficulties would appall anybody but these hardy Sabans. Donkeys are unable to ascend the terrible gradients, yet over unmade paths, where hand and knee climbing seems essential, the whites "head" heavy loads from the mountain top to Windwardside as often as three times a day.

Diet and Health

No doubt the rich soil would produce many exportable commodities, but we were informed that the people are intensely conservative and are unwilling to make experiments or undertake the rotation of crops. The government has been instrumental in founding an agricultural and horticultural "union," which may make for betterment both as regards cultivation and by importing stock to improve the island breed. But even with the present variety of products diet should be better. Sabans who have been in the United States appreciate the value of milk, fruit, and green vegetables, but the colored people use them little, while many of the whites suffer greatly from dyspepsia owing to a diet mainly of biscuits, bread, and tea. In this respect the influx of outside money, resulting in imports of salt fish and tinned goods, has been unfortunate. One suspects a deleterious change of diet since the self-supporting slave days. Nevertheless, the majority of the men look strong and healthy, and they are capable of working long hours on the hot hillsides and of carrying unbelievably heavy burdens on their heads up and down the steep slopes. They thus give some support to the contention of the Australian tropical doctors that the whites can maintain their standard in the tropics if, as a people, they guard health carefully and engage in strenuous manual work.

The white Saban women support the Australian theory from another angle. Debarred by the traditions of the slave days from healthy field labor or even from taking positions as housekeepers, nurses, or domestic servants, they spend their time, when they cannot migrate, largely indoors. As a result they appear to be pale, nervous, and high-strung and lack the rosy cheeks that previous observers have acclaimed. Some of the trouble may be due to the fact that the tropical climate is said to produce the usual female disorders. There is no doubt, however, that important factors are isolation, sedentary life, poor diet, insufficient care of teeth, and the long hours spent under oil light at the sedentary occupation of drawn-thread work (the so-called Spanish lace). In this last they show great skill

and in the past have earned large sums through sales in the United States. Like many isolated people, however, these women seem intensely conservative and do not make sufficient efforts to keep pace with the rapid changes of demand in the fashion centers. Also, like those in other tropical communities, these islanders are the inadvertent victims of the changing economic and social policies of the great cold-temperate lands. The recent history of Saba, for example, has been largely colored by events in the United States. Even this little island has felt the effects of a changed emigration policy, the purchase of St. Thomas, the temporary demand for labor at Panama, and the tariffs, which have now reached a figure of 68 per cent against Saban Spanish lace.

Another factor gravely affecting the women of Saba is the extraordinary disproportion between the number of women and that of men. The census of 1932 showed that there were 342 men, 655 women, 233 boys, and 219 girls in the island. A young couple marry, but frequently before the first child is born the husband seeks to increase the family resources by working abroad and usually stays away four or five years. He then returns to Saba but goes off again in a few months. This "economic birth control" is clearly shown by the age spacing in many families and undoubtedly affects the psychology of the women, although they bear their lot with remarkable patience.

We were told that the health of the children is satisfactory, as indeed is that of people of all ages in most parts of the island. Many white Sabans live to a great age. There is no malaria and few filarial or other tropical afflictions, and the present doctor has discovered no trace of hookworm, although one suspects its presence at Marypoint, where no sanitation exists. Oral hygiene, however, is in a most unsatisfactory state. It is lamentable that the schools give little or no instruction in this or other phases of hygiene and sanitation. What the Dutch can achieve by legislative action is shown by recent events at Simson Bay, St. Martin, where a very old white settlement was riddled with hookworm and was reduced to almost animal habits by extreme isolation. The government conducted a hookworm campaign, built privies, and supplied free shoes and uncontaminated water. It took some time to enforce these hygienic blessings, but the extraordinary health improvements since the new régime has been rigidly enforced are now recognized.

Marypoint: A Degenerate Community

The worst effects of isolation and inbreeding are to be seen in Marypoint. Here a community of some thirty to forty persons is composed almost entirely of seven families of Sagors, all closely intermarried and interrelated. The land seems fair, the settlement was once quite

flourishing and progressive, and a few of the people still possess good physique. Many, however, show evidence of mental and physical degeneration. The whole settlement receives government relief. The diet is miserable, consisting mainly of bananas and sweet potatoes,

FIG. 13

FIG. 14

FIG. 13—White agriculturalist on the mountain: he could not lift this "bun" unaided.
FIG. 14—Why the negroes are ousting the whites in Saba—a whole family works.

cassava, and fish. Little effort is made to provide the children with greens or milk on an island where vegetables grow in profusion and goats are numerous. The people have even lost their former knowledge of baking and carry bread, biscuit, and condensed milk from Leverocktown by "head." The state of this white settlement seems to offer two lessons. Situated as it is at a height of about 1000 feet and exposed to constant sea breezes, it indicates, when compared with the other cliff villages, that isolation and inbreeding can be as potent influences upon white settlement as climatic control is. The fate of this small community carries a warning to temperate countries against the efforts of company promoters to establish small white communities in isolated tropical regions. Several tragic examples of such attempts at settlement can be cited from the eastern Andes.

Education

During our stay in the island we visited all the schools, saw all children in attendance, and made careful inquiries as to methods of education, working standards, and care of health and teeth. Owing to isolation, the mixing of races, and the time spent in teaching the Dutch language, most of the children in both the government and parochial schools use books of a standard one year lower than that in the corresponding English or American grades. It is significant, however, that in the one almost wholly white school—the government school at Windwardside—the children are capable of working to the corresponding English grade. In regard to the relative ability of white and colored children, most of the teachers supported the evidence secured in Jamaica and the Cayman Islands by the Carnegie Institution and published in "Race Crossing in Jamaica."[8] The whites excel in mathematics and in other subjects requiring judgment, the blacks in music and rhythm, while the browns include a few children of very high ability but on the whole appear to be inferior to the children of either parent race. We were very favorably impressed by the white children and by the standards of the government school at Windwardside, which was conducted by a head mistress of English descent born on the tropical island of St. Martin and trained in the Netherlands. The children were alert, well dressed, and clean, although they lacked the rosy cheeks that impressed earlier visitors. It must be remembered, of course, that we visited the island at a time when diet had been poor for a considerable period owing to a long dry season preceded by a disastrous hurricane. It is most unfortunate that education in Saba finishes at the sixth grade and at fourteen years, although a few children pass on to teacher training. Even this elementary education has been established only some 25 years, and for this reason several of the most enterprising families had emigrated.

Increasing "Negrodation" of Saba

As regards the future, Saba, in spite of its large proportion of whites, is clearly turning colored, as are almost all the islands and borderlands of the Caribbean. In islands such as Jamaica, St. Kitts, and Barbados, which once contained thousands of white workers, the blacks are now in overwhelming preponderance, and only a handful of degenerate white peasants survive. On the mainland and in the former Spanish islands the "ethnological crimes" of the Portuguese, Spaniards, British, French, Dutch, and American slave owners are being continued by the great fruit and sugar companies, with the result that white plateau regions such as Costa Rica will

[8] C. B. Davenport, Morris Steggerda, and others: Race Crossing in Jamaica. *Carnegie Instn. Publ. No. 395*, Washington, 1929.

inevitably suffer nigrescence unless their governments awake in time. No matter how greatly altitude or trade winds mitigate tropical disadvantages in favor of white settlers, they cannot compete with prolific negro families, where men, women, and children all are workers, possessing great immunity from tropical diseases, and prepared to

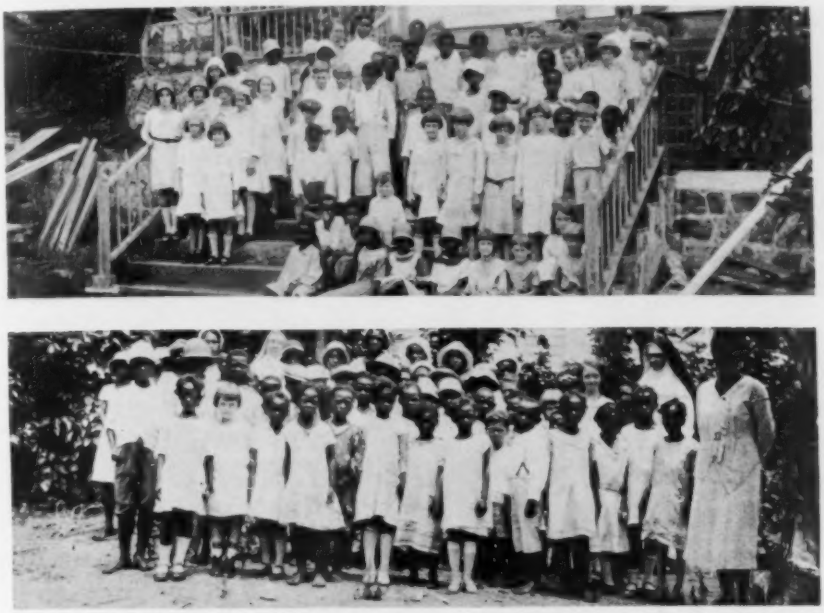

FIG. 15—"Negrodation" in Saba. Above: the Roman Catholic school of Windwardside, still largely white. Below: the Roman Catholic school of Bottom, almost all colored.

accept a far lower standard of life. Scientific medicine is hastening the process by improving the vital statistics of colored peoples.

The drift in Saba is clearly shown by recent figures. In the three years 1930–1932 there were 32 white births to 78 colored, while white deaths numbered 34 and negro only 42. Exact figures of the total white and colored populations are unobtainable, but one would estimate that the 1449 people can be roughly divided into equal numbers of colored and white. The schools give evidence of the same process. In the five schools of the island we counted 100 white to 110 colored children, but the proportion of colored was far higher in the younger than in the older grades. Furthermore, one understands that scientific birth control has made its appearance, and this, together with the long absences of the males, must react against the whites. As previously stated, the old settlement of Bottom has become largely colored, and here the negro is openly squatting on former white holdings, establishing an occupational ownership regardless of land titles or of rent. Curiously and perhaps unfortunately, the whites still retain much of the "race pride" of the days of slavery. Custom

permits them to keep small shops and supply goods to colored folk, as no doubt they did when each household was a self-supporting and slave-owning community. Yet, in spite of this and the fact that they undertake the heaviest field labor, such cash work as porterage, road making, and domestic service remains in negro hands.

It is a deplorable thing, this negrodation of Saba—the passing of the supremacy of a high-grade, kindly people to a less advanced race. Allowance must be made for the comparatively recent liberation of the negro, but at present his disregard of sanitation, his miserable cabins, his dirt and carelessness, and his neglect of the good "white" houses he so frequently occupies in Bottom contrast sadly with the standards of the people he will almost certainly supplant. The march of democracy and equality excludes any hope that the Dutch government will give any special consideration to the white population or will transport the negroes to the larger and sparsely inhabited island of Statia near by. One fears, however, that without some such measure this interesting experiment must cease, and with this conclusion all thinking Sabans agree. Judging from the history of the island, the passing of the whites will come from emigration and extinction rather than from absorption into the blacks—a conclusion supported by the courageous efforts to keep white made by generations of so-called "Red legs" in Barbados and Granada, "Chachas" in St. Thomas, and Germans in Seaford, Jamaica. Although Saba now contains a number of browns, some of whom bear the names of the old white families, miscegenation does not seem to be occurring at any great rate.

Conclusion

Thus Saba offers several lessons to the student of settlement. In the first place, the history of the island indicates the complexity of factors governing white settlement in the tropics—a tangle that can be unraveled only by a close study of tropical history and by detailed work on the problems of climate, acclimatization, soils, diet, isolation, inbreeding, and other aspects of sociology and economics. Secondly, it appears that cold-temperate-zone whites can retain a fair standard for generations in the trade-wind tropics if the location is free from the worst forms of tropical disease and if the economic return is adequate and the community prepared to undertake hard physical work. The third and last conclusion has been grasped by leaders in the United States and Australia but is one which some of the rulers of the white settlements on the Central American and African plateaus fail to appreciate—that, even when a white working community maintains itself for a long period against a tropical climate, diseases, isolation, and inbreeding, it will inevitably fall before the economic competition of a colored people who are prepared to accept a lower standard of life.

THE POPULATION OF THE MALAY PENINSULA

A STUDY IN HUMAN MIGRATION

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WHETHER or not those authorities who would place the original home of the human race in Indonesia are justified in their belief, there can be no question that, from the earliest times, Malaysia has been the scene of vast human migrations. There are few regions of the world around which the controversies of paleogeography have raged more furiously and the fascinating game of building and destroying imaginary land bridges for prehistoric man has been more enthusiastically played. But we are not concerned here with the ancient migrations: it is the present distribution of land and sea that sets the stage for our problem.

Consequences of World Position

The key to the modern history of the Malay Peninsula is its world position. In the first place, it is essentially focal in relation to the archipelago, a natural cradle of seafaring races. In the second place, emigrants from among the teeming millions of southern China adventuring westward and southward along the coast inevitably came upon the peninsula, and Chinese association with Malaya goes far back into history. Lastly, the Strait of Malacca, which forms the western seaboard of the peninsula, was predestined to become a section of the great ocean highway from the Western to the Eastern world, making of Singapore the "Gibraltar of the East."

We can distinguish several phases of the human history of the peninsula, all of which were natural, if not inevitable, consequences of its world position and the distribution of land and sea. Of the first phase, before the dawn of authentic history, we know only enough to picture a country mantled from shore to shore by the primeval rain forest and sparsely peopled by nomadic Negritos in the hunting and collecting stage of human evolution. That these were the stragglers from a great land migration in the days when the distribution of land and sea was very different from what it is today also is fairly certain.

Of the next phase—penetration by Mon-Khmer peoples from the north—we know little more. This influence appears to have affected only the northern part of the peninsula and to have left only the scantiest traces. The beginnings of the present population had to await the time when neighboring peoples attained such a degree of confidence in water travel that they dared the passage of the narrow seas of the Malay Archipelago and the Strait of Malacca.

Early Migrations of History

So we come to the dawn of authentic history for the peninsular Malay with the establishment of colonies by immigrants from the Sumatran kingdom of Palembang in the seventh and eighth centuries. Of the early history of these colonies we have more certain knowledge from the Chinese chroniclers than from Malay annals, which are largely mythological. For the Chinese junk had long since reached a stage of utility far beyond that of the primitive Indonesian boats, and Chinese sailors ventured many moons' sail southward and westward to Singapore and northward up the Strait. From these adventurers we get pictures of the early colonies that, if a little cynical in tone, are more illuminating than the panegyrics of Malay annalists writing under the shadow of the *keris*.

The Malay colonist had neither the energy nor the bushcraft of the aboriginal Semang and Sakai, and land travel in a country covered with almost impenetrable forest was beyond his conception. His only highway was the river. He rarely ventured far upstream; his settlements were practically confined to the river mouths and the coasts, and the power of the early Malay rajah extended little beyond the confines of his stockade. The spread of population over the land waited on the coming of occidental influence and enterprise.

The Arabs and Islam

The earliest western influence was exerted by the Arabs, who, by the close of the thirteenth century, had developed a very considerable trade with southern India, Kedah, Java, and Sumatra. They were traders and migrants in the narrowest sense and effected no conquest and no appreciable settlement, but the Malay Archipelago received from them the seed of Islam, which completely ousted Hinduism and Buddhism in this part of the world. This wholesale conversion of Malaysian peoples to Islam is of fundamental importance in the demography of the Malay Peninsula. Indeed, it may almost be said that it was the *only* event before the beginning of the nineteenth century that has played any appreciable part in determining the composition of the present-day population. For, if immigration into the peninsula had not begun until a thousand years or so later than it did, the country would still have filled with much the same peoples in much the same numbers, but, if the Malaysian component had not been barred by Islam from intermarriage with other components, a very different population might have developed.

As it is, the aboriginals have dwindled to less than 50,000; few Malays can claim descent from pre-nineteenth-century immigrants; the Chinese and Indians are, in the main, recent immigrants or their descendants or birds of passage; the Westerners are a mere handful

of sojourners who have always before them the goal of return to their native lands. The history of the country before the nineteenth century—the early Malay colonies, the capture of Malacca by the Portuguese in 1511, their seventy-year sway, the two-hundred-year

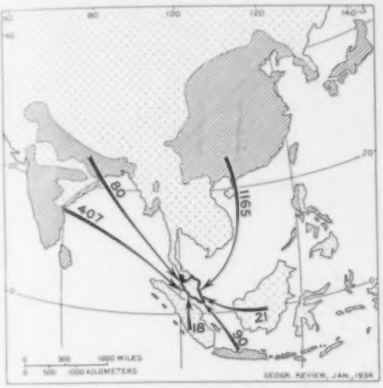

FIG. 1—Map showing the focal position of the Malay Peninsula (outlined by a heavy line) in relation to the great ocean highway between West and East and to the densely populated regions of Asia (diagonal ruling).

The arrows represent the main streams of immigrants. The figures against the arrows represent (in thousands) the *new* contributions of each region to the population of the peninsula—i.e. the numbers of individuals enumerated in the peninsula at the last census who were born in each region. Under 57 per cent of the population was born in the peninsula.

dominance of the Dutch, the coming of the British—is of interest as foreshadowing rather than determining the human history of the past century.

"NATIVES OF THE COUNTRY"

The greater part of the Malay Peninsula (i.e. all but the British colony of the Straits Settlements) is, in constitutional theory and political practice as well as in name, the country of the Malay; in actual fact the whole peninsula is a kind of no man's land in which geographic controls have produced, through the medium of migration, a population of unique characteristics and a civilization that is essentially alien. Malaysian immigrants from Sumatra, Java, or the other parts of the Malay Archipelago still follow in their thousands the sea routes of the early Malay colonists. Chinese migrants come and go along the sea highway that they have followed for a thousand years. Liners steam past Achin Head to Penang and southward to Singapore, bringing European administrators, planters, miners, merchants, and professional men to Malaya over the same great ocean highway that the Portuguese adventurers first traversed four hundred years ago. Other steamers bring to Malaya the Indian labor that is the complement of Western capital and enterprise. Let us look a little more closely at these streams of migration and the part they play in the economy of the peninsula.

First the Malaysian streams. Even if the convention that divides the population into Malay "natives of the country" and "alien immigrants" were anything more than a convenient fiction, it would still be true to say that it is the migrant who has made the country what

it is. The Malay, whose real home is Sumatra, not the peninsula, is the product of a marine-equatorial environment in which sustained effort is always peculiarly difficult, rarely necessary, and often unwise. Used to subsisting, with the absolute minimum of effort, on the bounty of nature, he naturally tends to move elsewhere if that bounty fails or if any change in his environment occurs that makes a life of leisured ease more difficult of attainment. So he came to the peninsula, and so countless thousands of his compatriots have come during the past century, to share in the fruits of the labor and the enterprise of other races.

A Malay is a Malay and is habitually accepted as a "native of the country and owner of the soil" without inconvenient inquiry into his antecedents. To him is accorded a preferential treatment that usually enables him to maintain his chosen life of ease unaffected by the stress and strain of life that are the lot of the recognized immigrant. Secure in his privileges, he stands apart and watches with a kind of wonder, not untouched with disdain, the migrants from less enervating climates applying their superior energy, enterprise, and resources to the development of the country for his benefit as well as their own.

While it is a matter of common knowledge that a very large proportion of the Malay population consists of recent immigrants and that a still larger fraction cannot claim pure peninsular descent for any considerable number of generations, the lack of actual migration statistics for Malaysians makes it difficult to demonstrate the facts. An idea of the true position may, however, be obtained by deductions from the census statistics of the Federated Malay States—the heart and epitome of the peninsula—taken in conjunction with what is now known of the "natural increase rate" of the Malaysian races. The Malay population of the Federated Malay States in 1891 was 232,000, and a very liberal estimate of the natural increase of such a population in the next 40 years is 118,000. If this population had been a settled and isolated one unaffected by migration, it would have increased to about 350,000 by 1931: actually the Malay population enumerated at the 1931 census was nearly 594,000. It follows that some 244,000 of the individuals enumerated at the recent census were either new immigrants or descendants of immigrants of the last 40 years.

Stated in other words, less than 60 per cent of the present Malay population is of over 40 years' standing in the peninsula. But actually the long-standing Malay population must be even smaller than these figures suggest, as a large number of immigrants and their peninsular-born children ultimately return to their country of origin and there is a continuous process of substitution going on. It is clear that only a negligible fraction of the Malay population consists of descendants of

pre-nineteenth-century immigrants and that more than half of it has less than 50 years' prescriptive right to the title "owners of the soil." The Malays are, in fact, merely immigrants of generally longer standing than the other migrant races represented in the peninsula and are in no sense an autochthonous population.

Javanese and Sumatran Immigrants Compared

There are two major streams of immigration into the peninsula from neighboring islands, one from Java and the other from Sumatra, the individuals composing the latter stream being commonly designated "Malays," while the former are distinguished as "Javanese." These terms, however, cover a very wide range of ethnographic variation, and there are also large contingents from Bawean, Borneo, Celebes, and other islands of the archipelago. The Sumatran stream has continued unbroken from the beginning of Malay association with the peninsula, and there is no ethnographic distinction between the Sumatran and the peninsular Malay. We may, in fact, regard Sumatra and the peninsula as one area from the ethnographic point of view, and it should be recognized that migration across the Strait of Malacca is freer and more considerable than across the main divide of the peninsula itself.

The new Malay immigrants from Sumatra intermarry freely with the Malays already in the peninsula. The Javanese, Boyanese, Bugis, and others retain their racial individuality longer, but, owing to the universality of Islam, there is no actual barrier to intermarriage, and assimilation is not long delayed.

The immigrant from Java, as long as he retains his individuality, takes a different position in the scheme of things from the Sumatran. He has not the latter's profound disinclination for work, since, unlike the Malay, he comes from one of the most densely populated regions in the world, where the struggle for existence is already acute. He has therefore played, as a laborer, a certain part in the economy of the country. On the other hand, as long as he is recognized as a Javanese he does not enjoy the privileges of the Malay, and this fact tends to encourage assimilation.

The Chinese Immigrants

Taking British Malaya as a whole, the 1931 census showed that Malaysians (using the term in its broadest sense to include all indigenous peoples of the archipelago) aggregated 44.7 per cent of the population. The remaining 55.3 per cent consisted of definitely nonindigenous races, the largest and—setting aside the numerically insignificant European contingent—by far the most important component being the Chinese, which was nearly two-fifths of the total population of all

races. As has been pointed out above, Chinese association with the peninsula goes very far back, and the stream of migration between southern China and Malaya has existed for centuries. We are on surer ground in gauging the ever changing volume of Chinese migration than in the case of Malaysian, as actual statistics of immigration have been available for many years past.

The Chinese population of British Malaya at the 1921 census was nearly 1,175,000 and at the 1931 census more than 1,709,000. Of the increase of some 535,000, the excess of births over deaths accounts for about 55,000 only, so that the balance of immigrants over emigrants amounted to 480,000. The recorded total of immigrants over the decade being nearly 2,418,000, we know that 1,938,000 Chinese must have left the country during the same period. In other words, for every hundred arrivals there were over eighty departures—a striking case of migration and a convincing proof of the constantly changing individual composition of the population.

The areas of southern China from which the vast majority of the immigrants come are densely populated, and the struggle for existence there is keen. Unlike the southern Indian immigrant, the Chinese is an enterprising and extremely self-reliant person who migrates to the Malayan El Dorado on his own initiative to seek his fortune and leaves it again at his own sweet will. The Malay being useless as a laborer, European enterprise and capital can operate only through the medium of immigrant labor: the Chinese have seized their opportunity by meeting the demand thus arising, and the phenomenal development of Malaya during the past two decades has been due largely to their industry, enterprise, and commercial genius. For, while the vast majority of the immigrants come to Malaya as manual laborers, there is no type of human activity in which the Chinese in Malaya do not engage with marked success, and many an industrial millionaire and many a merchant prince have risen from their ranks.

The direction and volume of the streams of Chinese migration at any given time are determined by a complex set of factors and tendencies, the resultant of which may be termed the relative attraction of Malaya at that time. A bad harvest or political troubles in South China tend to stimulate the flow Malayawards, as does a boom in the rubber or tin on which the prosperity of the peninsula depends. A slump in Malayan produce, such as exists today, or an improvement in conditions in Kwangtung will have the contrary effect. The balance between immigration and emigration, or migrational surplus, is constantly changing, not only in amount but even in sign. It is possible to detect a certain seasonal periodicity in the streams of migration as long as conditions remain more or less stable, but this periodicity is largely masked by the more enduring tendencies evoked by booms and slumps in Malayan produce.

Provenance of the Chinese

All but a negligible fraction of the Chinese migrants come from the southern provinces of Kwangtung, Fukien, and Kwangsi and may be divided into at least eight distinct racial types. The distinctions are reflected in language and mode of life and, to a large extent, in chosen occupation. These differences in turn affect the distribution of the various Chinese races over the peninsula. For instance, the Hokkiens, while extensively engaged in agricultural pursuits, form the bulk of the trading and shopkeeping classes and are more than twice as numerous as any other race of Chinese in the Straits Settlements. In the Federated Malay States, however, their numbers are far surpassed by both the Cantonese and the Hakkas, who are more rural in habit and are mainly engaged in agriculture and mining.

It is particularly interesting to observe, at a time when there is a great deal of loose talk about "China," "the Chinese government," and the like, that even among the immigrants into little Malaya, who come from a relatively small area of South China, there is a diversity of language, allegiance, mode of life, and characteristics generally similar to that found among representatives of different European nations. In any given batch of immigrants from China into Malaya may be found half a dozen individuals who are actually unable to converse with one another until they have picked up a smattering of the "pidgin Malay" that is the lingua franca of the country.

The Indian Immigrant

Next in importance to the Chinese immigrant comes the Indian. The fundamental reason for his presence is again the disinclination of the Malay to labor at a wage for others. The rapid development of the peninsula, and in particular the growth of the rubber-plantation industry, necessitated the importation of large supplies of agricultural and general laborers, and the demand has been largely met from Madras. At the 1931 census 624,000 Indians were enumerated, of whom 515,000 were classified as Tamils, 33,000 as Telegus, and 35,000 as Malayalis. Of the 624,000 Indians of all races 425,000 were enumerated on the rubber estates throughout the country. Thirty-one thousand immigrants from northwestern India were recorded, mainly Punjabis.

The Indian population of Malaya consists almost entirely of migrants, and the settled Indian population is of negligible proportions. There is, however, a characteristic difference between the Madras Indian and the Chinese immigrant, in that the former has none of the self-reliance and initiative of the latter. The Tamil laborer is "imported," is looked after as long as he is required in Malaya rather like the child he is, and is ultimately sent back to his native land.

He has not the intelligence, education, or enterprise to rise, as the Chinese laborer often does, above the level of manual labor, and the very small fraction of the Indian population that engages in mercantile and other pursuits is composed almost entirely of immigrants of a different class and place of origin. The police forces of the peninsula are partly recruited from the Punjab, and Punjabis are also largely engaged in the similar occupation of watchmen and guards in private employ. The Indian population that is neither Madrasi nor Punjabi numbers only a few thousands, among whom are to be found Bombay merchants, Bengali clerks, peddlers and food hawkers, and odd adventurers from every part of the Indian Empire.

The Malaysian, Chinese, and Indian components of the population enumerated at the 1931 census aggregated 97.9 per cent of the whole, the remaining 2.1 per cent being composed of Europeans (0.4 per cent), Eurasians (0.4 per cent), and "Other Races" (1.3 per cent). The Europeans and the vast majority of individuals of "Other Races" are migrants in the narrowest sense, but the Eurasians form a distinctly settled community with its own "natural increase" and its own customs and traditions. There is today but little fresh intermixture of European and Asiatic blood, and many of the Eurasian families of the Straits Settlements can trace their descent back to the early Portuguese, Dutch, and British adventurers.

British Intervention and Its Effects

Having glanced at the individual streams of migration that have combined to produce the heterogeneous population of Malaya, we may return to the examination of the factors that determine the volume and direction of these streams generally and the distribution of the migrants. The demographic history of the peninsula may, for all practical purposes, be regarded as beginning when Stamford Raffles ran up the British flag on Singapore Island in 1819. The development of Singapore was as rapid as it was inevitable; its position on the ocean highway to the Far East predestined it to become one of the great ports and *entrepôts* of the world, but for the greater part of the nineteenth century it was little more. The hinterland remained largely an undeveloped country sparsely populated by Malays concentrated in settlements on and near the coasts and along the lower courses of the rivers, by scattered communities of Chinese who penetrated as far as the foothills of the main range in quest of tin, and by the aboriginals who roamed the primeval forest that still covered the whole face of the land almost untouched by man.

But storms were brewing that, in the end, called for British intervention and with it the opening of an entirely new phase. The migrants could not live at peace with one another; the strong preyed on

the weak, and the only law was the law of the *keris*. The mangrove-fringed coasts seamed with creeks were a happy hunting ground for a race that took to piracy like ducks to water. The Malay rajahs were lucky if they could defend their own stockades against the pirates, and the task of suppression was quite beyond their powers. The rivers were still the only highways, with the population concentrated along their lower courses, and, as the pressure there and on the coasts increased, the spheres within which the different chiefs claimed to hold sway overlapped, and internecine warfare developed. The increasing pressure exerted by the Chinese tin miners and the exactions levied on them by the Malay chiefs led to serious clashes.

So one Malay ruler after another sought the assistance and protection of the British power, and Western standards of law and order replaced the law of the *keris*. Roads were made through the forest here and there on the western side of the main divide and even over it into Pahang, and along these roads and the railways that followed them passed increasing numbers of migrants. The primeval forest, hitherto almost untouched by the puny efforts of the Malay settlers, went down before the European pioneer and his Chinese allies. The former began to import Indian laborers to help in the struggle, and the forest retreated farther and farther from road and rail. Opencast tin mines came into existence and multiplied on the plains and along the western foothills of the main range; mining villages sprang up where these mines were thickest and at focal points in the growing system of communications; the villages developed into considerable towns, populated mainly by Chinese, whose commercial genius, industry, and adaptability found ample scope in meeting the needs of the rapidly growing rural population. European capital and management introduced the large-unit or "estate" system of agriculture, and the area under cultivation, mainly with coffee and coconuts, steadily increased and with it the volume of the streams of Indian migrants.

The Rubber Boom

Then came rubber, which acted like a magician's wand waved over Malaya. Given an equatorial climate, the Pará rubber tree (*Hevea brasiliensis*) will grow on almost any soil and survive almost any degree of neglect or maltreatment. Malaya had the climate, it had almost unlimited areas of virgin land, it had a nucleus of British planters and a readily developed link with British capital. Furthermore, it had unlimited supplies of labor available at no great distance in Madras and South China. The demand for rubber was increasing at a phenomenal rate in the first decade of the twentieth century as motor cars multiplied in Europe and America, and in 1910 a hectic boom occurred in Malaya, followed by ten years of amazing affluence.

British capital was poured into the country, and peasant and immigrant European alike had but one idea—to plant rubber and yet more rubber and share in the golden harvest. Sumatran Malays came over in their thousands, obtained land for a mere song—for were they not Malays?—and planted rubber; Javanese indentured laborers were imported by those estate owners who preferred them to Tamils, and thousands of their compatriots came over to plant small holdings; Chinese poured in, attracted by the general affluence and the concomitant prosperity of the tin-mining industry; the European planter imported more and more laborers from Madras.

Thus the population of British Malaya increased in the second decade of the present century from about 2,673,000 to 3,358,000, the increase being due entirely to immigration, as the peculiar composition of the population, with its huge deficit of women, precluded any excess of births over deaths. In 1920 came a setback. The inflated demand for rubber and tin due to the Great War and the extravagance of the immediate post-war period collapsed, and the world could not absorb the produce of the rubber trees planted during the "gold rush" of the previous decade and now in bearing nor of the tin mines capitalized, opened up, and equipped during the same period. Tin and rubber slumped heavily; the tide of migration slowed, halted, and turned; and the population began to fall and continued to fall for about two years.

Then the export of rubber was artificially restricted, the price rose, and an illusion of the old affluence was produced. The migrants began to pour in again, and the population rose from the 1923 minimum of less than three and a quarter millions to a maximum of more than four and a half millions early in 1930. In other words, over this period there was an immigrational surplus of the order of 200,000 a year.

Peak of Prosperity and Catastrophic Fall

The peak year of Malaya's prosperity was 1926, when the volume of trade was greater than the aggregate volume for all the other British colonies and protectorates put together and the value of exports per head of population exceeded that of any other country in the world. This was also the peak year of immigration, and the flood of immigrants fell off rapidly in the next three years, until, in 1930, the tide turned and an unprecedented outward flow set in. The waning of the astounding prosperity of the country is of course partly due to the general world depression, but the catastrophic character of the fall is primarily due to the fact that the *potential* production of rubber from trees planted during the "gold rush" is far in excess of any conceivable consumption for many years to come. The magician's wand that transformed the face of the land in a few short years has become the curse of Midas, and the migrants are fleeing the country.

The peak population of the peninsula was probably well over four and a half millions; by April, 1931, when the last census was taken, it had fallen to 4,346,000; today it is probably well under four millions, and it is still falling. Data are not available for anything like accurate estimates of the population of all parts of the peninsula, but, for the Federated Malay States alone, which may be taken as the epitome of the whole, we have a fairly accurate idea of what has happened. The census population of 1921 was about 1,325,000; the peak population of 1929–1930 may be estimated with some confidence at 1,900,000; the census population of April, 1931, was 1,713,000; the mean population of 1932 is estimated at about 1,490,000; the population at the time of writing (May, 1933) is almost certainly as low as 1,400,000, and it is still falling. The emigrational surplus over a period of about four years has been approximately half a million or considerably more than a quarter of the population at the beginning of the period.

Structure and Configuration of Malaya

We may now turn to consider in rather more detail the distribution of the migrants over the face of the land and the factors that determine this distribution. The accompanying population-density map, which shows the position as at the time of the 1931 census, brings out clearly the general features of the distribution and suggests how largely it is determined by the simple factors of structure and configuration.[1] The peninsula has a well marked "backbone," or main divide, running roughly north and south as far as Malacca, where it dies out. East and west of this main divide are a number of minor ranges with the same general trend lines. Outside these again are the coastal plains, which are mainly alluvial, while in Johore, south of the point where the main range peters out, is an area of lowland that appears to be of greater age and was probably produced by the planing down of the old land surface to undulating country with isolated land masses that were at one time islands.

The main divide, though often loosely described as the central range, is considerably nearer to the west than to the east coast, and the principal development of the country and about five-sixths of the population are confined to the narrow western coastal plains, which form a belt some six hundred miles long and generally less than fifty miles in width. The "central" highlands are characterized by very steep slopes, precipitous ravines, and knife-edged ridges and spurs: for the most part they constitute an area populated only by a few small bands of nomadic aboriginals and quite inadequate for development; they also form an effective barrier to movement from west to east.

[1] Compare the maps, Figures 2 and 3, accompanying J. B. Scrivenor: The Physical Geography of the Southern Part of the Malay Peninsula, *Geogr. Rev.*, Vol. 11, 1921, pp. 351–371.—Edit. Note.

The north-south ribbing of the highlands governs the trend of the rivers, which run generally north and south in their middle reaches and east and west across the coastal plains to the sea. There is one notable exception to this rule in the Kelantan River, which preserves a generally north and south direction throughout its length.

Add to this brief sketch of the structure and configuration of the country the summary statement that the "core" consists of a granitic intrusion on a large scale, and we have a sufficient basis for a general explanation of the distribution of the immigrant population. A fuller, but still highly condensed, account of the geography of the area is given in the writer's report on the 1931 census of British Malaya, but the above sketch will serve for the present purpose.

Distribution of Population

The early migrants naturally settled on the west coast of the peninsula, and the pre-nineteenth-century Malay colonies were mainly confined to the estuaries of the western rivers. The early Chinese migrants also favored the west, partly because of the existing colonies there, but also because the "tin line" where the foothills come down to the plain is so much nearer the coast. Later, occidental adventurers passing along the great ocean highway of the Strait of Malacca as far as Singapore had no sufficient inducement to draw them aside into that dangerous and unproductive backwater of the China Sea that borders the east coast of the peninsula.

Thus at the beginning of the modern history of Malaya there were several established nuclei on the west coast such as in Kedah, Penang, Larut, Klang, Malacca, and Muar, and a center of British influence at Singapore. On the east side of the peninsula there were only Malay settlements of little consequence, the most important being on the great coastal plain of Kelantan in the far north. The same causes that concentrated the original streams of immigrants on the west have persisted and have resulted in the progress of the west-coast states being far in advance of the development of the east. There are no harbors on the east coast fit for ocean-going steamers of any size, and the "central" highlands form a formidable barrier to migration from west to east.

Areas Especially Attractive to the Migrant

A glance at the population map shows a fairly continuous belt of population of a general density of about 150 persons to the square mile over the whole of the western lowlands. This belt is broken by a number of patches of low density and by five principal areas of high density. The low-density areas represent swamps and outlying hills still covered with virgin forest, mainly reserved. The high-density

areas may be taken as regions with special attractions for the migrant. The eastern boundary of the belt coincides for the most part with the foothills of the main range, except in the south, where there is no such definite line of demarcation. On the eastern side of the peninsula there is only one area of high density.

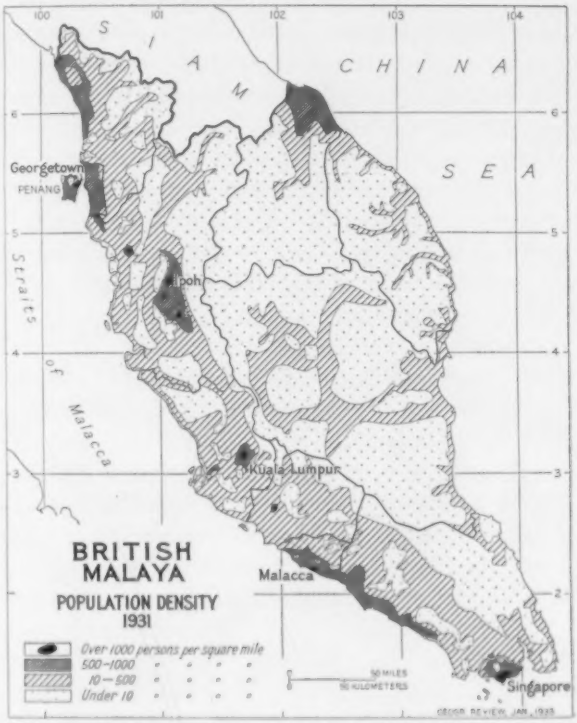

FIG. 2—Distribution of population in the Malay Peninsula, after the map on a scale of 18 miles to an inch accompanying the official report on the 1931 census of British Malaya.

The densely populated areas, in all of which the population approximates 700 to the square mile, are of three broad types: areas of continuous agricultural small holdings, continuous mining areas, and suburban areas. It is in areas of the first of these types that the bulk of the Malay population is concentrated, and, at any rate as far as the west coast is concerned, this population is continually being recruited by fresh immigration from Sumatra, Java, Banjermasin, and other parts of the archipelago. On the west, all the mainland coastal areas are of this type, the plains of Perlis and Kedah north of, and of Province Wellesley opposite, the island of Penang being great rice-growing areas. The coastal strip about and south of Malacca is characterized by small-holding cultivation of a more mixed type in which rubber predominates. The plain of Kelantan in the extreme northeast is also an agricultural small-holding area with an almost pure Malay

population relatively little affected by migration at the present time. Here a peculiarly extensive coastal plain, low-lying and eminently suited to the cultivation of rice, and traversed by one of the largest rivers in the peninsula and the only one with a persistently north and south course, has bred a pure and settled Malay population of long standing.

The island of Penang is partly of the first type with an essentially Malay population and partly suburban with a mixed population in which Chinese predominate. The large inland area within which the town of Ipoh is located and the small area to the northwest of it belong to the second type (tin-mining areas), the first comprising the famous Kinta Valley and the latter the older and now declining Larut mines. It is here that the bulk of the Chinese rural population is found, and other races are relatively little represented. The position of these areas and also of that surrounding Kuala Lumpur—which may be classed as partly a mining and partly a suburban area—are determined mainly by the geological structure of the country: they are situated almost under the shadow of the foothills of the main range at the points where its acid granite is particularly rich in tin and sends down the richest alluvium for the miner.

The areas of medium density, normally about 150 to the square mile, are of two broad types—discontinuous small holdings and estates. In the former type of area Malays and Chinese are chiefly represented; in the latter are to be found the vast majority of the Indian population and a few Chinese, but hardly any Malays.

The Urban Population

In a country with a predominantly migrant population engaged principally in the production of primary commodities the tendencies to urbanization and the relations of urban and rural population are entirely different from those that obtain in an industrial country with a settled population. Setting aside Singapore, the relatively small urban population exists to serve the needs of a large rural producing component—a state of affairs radically different from, if not the converse of, those existing in Europe and America. The urban populations of Malaya are produced mainly by centralization of the administrative, supply, and transport services required by the rural population and by organizations for the marketing of rural produce. The urban population of Singapore is determined partly by these causes but also by its position as a world port and *entrepôt*.

There are in the peninsula (including the islands of Penang and Singapore) some 120 towns with a population of more than 1,000 persons, 18 with more than 10,000, 6 with more than 25,000, and 3 with a population exceeding 100,000. The population of the city of Singapore,

as returned at the census of 1931, was 445,719; Penang showed 149,408; on the mainland the only town with a population exceeding 100,000 was Kuala Lumpur (111,418), the capital of the Federated Malay States. Broadly speaking, the principal inland towns of the peninsula all started as mining villages and are to be found close up to the foothills. Working from north to south on the density map we see Taiping, the town of the Larut tin fields, Ipoh, Batu Gajah and Kampar in the Kinta area, Kuala Lumpur, and Seremban. Kuala Lumpur was originally the center of a rich mining area; it is equidistant from Penang and Singapore and is a natural node in the system of communications. Here join three major lines of communication: the natural trunk line from south to north; the west-east line to Port Swettenham, the only harbor between Singapore and Penang fit for ocean-going steamers; and the only road over the main divide to the east.

Taking the peninsula as a whole, nearly 30 per cent of the population is "urban" in the sense that it is located in towns of more than 1,000 inhabitants. In the Straits Settlements, dominated by the city of Singapore, which contains more than one-third of the population of the colony, the figure is more than 60 per cent; in the Federated Malay States, where the urban population may be described as almost entirely ancillary to the rural, the figure is 25 per cent.

So far we have been considering principally the tendencies when there are an immigrational surplus and a growing population. It is necessary, however, to recognize that the urban population is more settled than the rural. When the pendulum swings over, as it has now swung, and there is an emigrational surplus, the bulk of this surplus is at first supplied by the rural laboring population. The urban population, which has a much higher ratio of females to males and is more largely organized in families, is not so easily uprooted by the winds of economic adversity. It cannot, however, stand indefinitely against the economic blizzard, and, as the rural producing population, which it exists to administer and serve, dwindles, the urban population develops its own emigrational surplus.

Throughout the peninsula the urban population is overwhelmingly Chinese. In the extreme case of Singapore, of the total population of 445,719 enumerated at the 1931 census no less than 340,614 were Chinese. In Kuala Lumpur 67,929 out of 111,418 were Chinese. In the Federated Malay States as a whole 63 per cent of the urban population was Chinese, 21.5 per cent Indian, and 12 per cent Malaysian. Looking at the matter from the opposite angle, we find that, for the peninsula as a whole, nearly 50 per cent of the Chinese population was urban and more than 30 per cent of the Indian. The Malay population is everywhere essentially rural, only 11 per cent of this component being located in "towns." Furthermore, this figure is deceptive in that it is swollen by the relatively high percentages in such backward

states as Kelantan and Trengganu where the population is almost pure Malay and the "towns" are mere close aggregations of households living under conditions that are really more rural than urban in character.

Problems of a Migrant Population: Administrative

Populations, the size and composition of which are so largely determined by migration and so little by the normal processes of natural

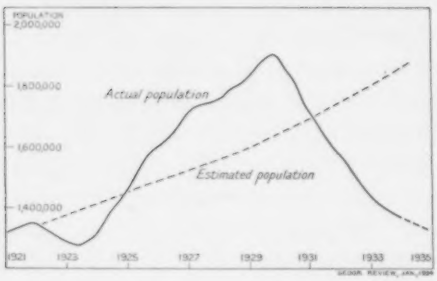

Fig. 3—Graph showing the inapplicability of the conventional methods of population estimate to such a country as British Malaya where the growth of the population is mainly determined, not by births and deaths, but by migration.

increase and internal adjustment, present unique problems—social, economic, and administrative. In the first place, there is no likelihood of the population as a whole conforming to any simple law of increase; in the second, it is a conglomerate of peoples of different races and creeds whose customs and whole attitude towards life cover a range of variation of a totally different order from any found in nonmigrant populations; in the third, the proportions of these widely varying races are continually changing within wide limits; lastly, even within a given racial group, to say nothing of the population as a whole, all demographic indexes such as the sex ratio, marriage rate, birth rate, death rate, and age distribution are always abnormal and continually vary in a manner that vitiates all orthodox methods of analysis and interpretation.

The consequences of the first of these peculiarities of the population of Malaya are only now beginning to be dimly recognized. The ingrained habit of mind that assumes that populations must increase, and increase more or less steadily, has hitherto determined all policies—commercial, municipal, and governmental—with results that have seriously aggravated present financial difficulties. Plans laid and commitments assumed in the confident anticipation of a population increasing at a rate of 3 per cent a year are apt to become seriously uneconomic and embarrassing when the population proceeds to decrease at a rate of about 5 per cent a year for an indefinite period.

As to the racial heterogeneity of the population, it is obvious that this imports special problems in administration, which are aggravated by the superiority in enterprise and industry and the general economic

predominance of those sections of the community that are most distinctly migrant. It must suffice merely to suggest this aspect of the consequences of migration; it cannot be pursued without entering into a political discussion that would be out of place in this study, and we must return to the social and demographic aspects.

Social and Demographic Problems

Broadly speaking, the immigrants from China and India and, to a lesser degree, those from the islands of the archipelago are predominantly male. The proportion of females has, however, steadily risen, and the sex ratio of females to males in the population has risen similarly. In 1911 there were only 572 females to every thousand males, in 1921 the figure had risen to 628 and at the 1931 census to 688, and it is now estimated at about 740.

This always abnormal and constantly changing sex ratio produces all manner of peculiar features in the vital statistics of the country, and failure to recognize this fact has led to a number of erroneous conclusions. The most important of these fallacies, which has for many years cast on Malaya an entirely unmerited stigma, arises from failure to bear in mind that, while both men and women are mortal, only women can give birth. Up to late in the second decade of the present century the number of women in Malaya was relatively so small that, despite their fecundity and a general death rate by no means discreditable to an equatorial country, it was utterly impossible for the number of births to exceed the number of deaths. The country was accordingly saddled with a "natural decrease," and lurid pictures were drawn of a "tropical death trap" in which the population was saved from decimation and ultimate extinction only by continual replenishment from outside. No picture could be farther from the truth. The truly *natural* increase rate of the various Asiatic races in the peninsula has now been shown to lie between 1.5 and 2 per cent a year. Even with the existing artificial sex ratio, the birth rate for all races together in the Federated Malay States today is about 37 per mille, and, as the death rate is only 20 per mille, the increase due to the excess of births over deaths is at the rate of 1.7 per cent a year.

The inferences drawn from birth and death rates, vitiated by large errors in the estimation of basic population and uncorrected for variations in sex ratio and age distribution, have produced other curious illusions. Gross overestimation of population at the present time having, for instance, converted a true birth rate that is rising fast as a result of improvement in the sex ratio into one that is falling noticeably, responsible authorities have been betrayed into solemn speculations as to the growth of contraceptive practices among the Asiatic population! In point of fact, since the basic population is estimated

(by the orthodox progression method from the last intercensal increase) at a figure about 8 per cent above the true one, the fecundity of the population would have to have increased by the same proportion to *show* any increase. The Asiatic woman does her best, but there are limits! In similar fashion, health authorities have been congratulating themselves and the community on an apparent fall of nearly 50 per cent in the apparent Chinese death rate in a space of two years, when it has really risen slightly.

The Incalculable Forces of Migration

The truth of the matter is that the orthodox methods of estimation and analysis, developed for a population that is only slightly affected by migration, break down utterly when applied to a population in which migration is the dominant factor. It is necessary to get back to first principles in considering practically every question in Malaya that has a human aspect. Ready-made formulas are of little use when the size and composition of the population are determined not by the natural and statistically amenable events of birth and death but by the interplay of the geographic, psychological, and economic forces that are the mainsprings of migration.

And what, after all, do we know of these forces? Certainly not enough to enable us to forecast with any great confidence the population of a few short years ahead. There is always something incalculable about migration. We know, or think we know, that the salmon returns to the river in which he was spawned and that he will continue to return at intervals while he lives. We know that one covert will hold, year after year, more woodcocks, more pigeons, or other migrant birds than another. But no knowledge we have acquired will tell us why in one year the population of one river or one covert teems, while in another it is almost deserted. We may guess but we cannot know, and we can hardly even guess ahead. Can we do much better for man? The migrations of brute creation we say are instinctive and instinct is immutable—fine phrases, but they do not seem to help us much. Man, we say, is a reasonable creature; if so, another reasonable creature ought to be able to predict his migrations. Evidently there is something wrong with our premise.

THE MURRAY RIVER BASIN

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THE basin of the Murray River is the most important economic unit of the physiographic divisions of Australia. Its area (414,000 square miles) is more than twice that of Germany and is about one-seventh of the total area of the commonwealth. It lies, moreover, in the southeast of the island continent, the portion most favorably situated as far as climatic conditions are concerned.[1] While the western margin touches upon the sand ridges and porcupine grass of the desert interior, the greater part of the basin is grassland and savana. The eastern and southern margins are largely occupied by hill and valley, with timbered ranges, high fertility, and a wide variety of productions. In the north the basin reaches almost to the tropics, and it stretches southward to latitude 37° S.

Though a powerful and capable federal commission has been in control of its waters for over twenty years, it is not the custom in Australia to think of the Murray Basin as a unit. The feeling for "state rights" overrides the more rational way of considering the basin. Moreover, the interests of the marginal areas are linked very closely with those of the nearer capital cities. The human forces that control the Murray Basin do not reside within that basin, and it has come about that in their tendencies they are to a large extent antagonistic to the chief natural geographical factors. Now in an area so varied, so fertile, and so extensive transport is an outstanding problem. In this respect somewhat of a tragedy has been enacted. The natural course whereby the wealth of the basin should go to the outside world is by the easy grades downward towards the mouth, whether by water, which is slow but cheap, by rail, or by road and motor, the likelier development of the future.

Transport Problems: Railroad Competition

In the early history of the Murray Basin, commencing about 1853, quite an extensive system of river transport developed. During the third of the present century that has passed a dramatic change has taken place. The figures of river traffic, compiled by the Harbours Board of South Australia, reveal the fact that there is still a considerable local traffic on the extreme lower portion, chiefly of livestock, wool, hides, wheat, flour, etc.; but this trade is curiously irregular and is diminishing. The general river trade, as indicated by the records of

[1] The fieldwork necessary for the physiographic and economic study here presented was made possible by grants from the Endowment Fund of the Commonwealth Council for Scientific and Industrial Research, which assistance is here gratefully acknowledged.

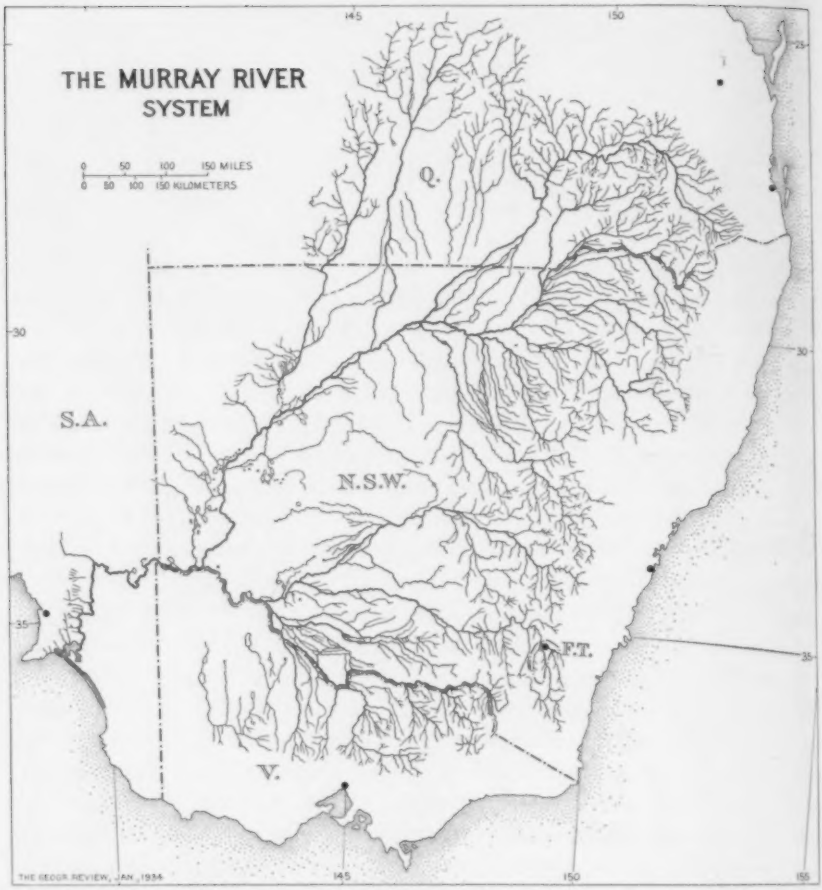

FIG. 1—The Murray River system. For a classification of the types of tributary streams see Figure 4b. Scale of the map 1 : 13,500,000.

the Morgan wharf, shows a maximum (1921–1924) of about 40,000 tons per annum, diminishing to 4000 tons average for the three years just completed. It is an interesting commentary on the ways of self-governing peoples that, while millions of pounds were being spent to construct a series of locks to insure the continuous navigation of the river, the states most concerned were at the same time spending further millions in a series of competitive railways. These "tapped" the Murray at seven points in South Australia and at eight points in Victoria. The railways were built by the state authorities; the locks were built by a federal commission representing the commonwealth and the three states. In the contest the railways have won; practically the whole of the transport is done by rail, though the competition of road and motor is growing.

Figure 2 strikingly emphasizes the lack of unity in transport in the basin. It will be seen that from Brisbane in Queensland a dendritic

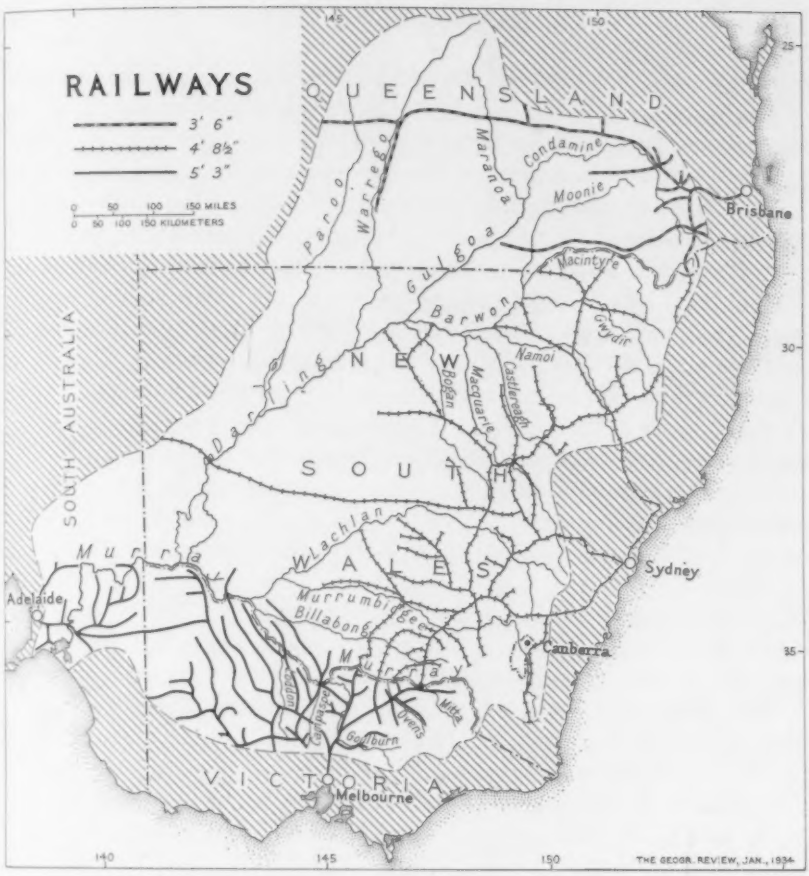

FIG. 2

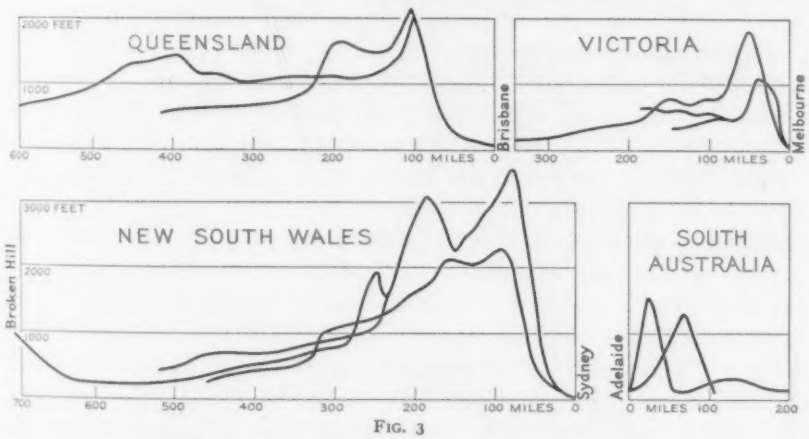

FIG. 3

FIG. 2—Map of the railway systems of the Murray Basin.

FIG. 3—Graphs showing the lengths and grades of the chief railways into the Murray Basin from Brisbane, Melbourne, Sydney, and Adelaide, respectively.

railway system has been developed to bring into this city the products of the Murray Basin. This railway system has a 3-foot 6-inch gauge and cannot be linked up with that of the adjoining portion of the basin. A still more extensive dendritic railway system converges on Sydney from the Murray Basin in New South Wales. This system has a gauge of 4 feet 8.5 inches and so cannot be linked with adjoining portions of the basin. In the south a closer network converges on Melbourne. The railway gauge here is 5 feet 3 inches, and it will be noted that geographical conditions have in this case overridden state rivalries so that an arrangement has been made whereby at five or more points the Victorian railway system is permitted to extend into Riverina, New South Wales. The South Australian railway system also has a 5-foot 3-inch gauge and is constructed not only to take the trade of the Murray Basin from the various settlements and from the adjoining wheat lands but also to pick up river-borne products at Morgan and Murray Bridge and carry them over the ranges to Adelaide.

The relative heights, grades, and distances on the railways are shown on the graph, Figure 3, and are in striking contrast to the gentle and easy grades that may in some wiser day be provided by a road system converging from all parts of the Murray Basin towards a harbor near the river mouth. One recent development in the story of the Murray Basin is the appearance of a capital city within that area; Canberra, the infant capital of the commonwealth, lies in the highlands of the east, on a tributary of the upper Murrumbidgee.

The Basin As a Unit: Its History

Anyone regarding the separate developments of the Murray Basin areas of each state may find justification for the present scheme of things, but an inquiry into the rational development and exploitation of the area as a single geographical unit suggests that there are other ways of viewing the problem. In the following series of maps (Figs. 5–6) the basin is treated as a unit.

The discovery of the Murray River and its chief tributaries was carried out within a period of twenty years just a century ago. It has been pointed out by a European traveler[2] that in most countries the great rivers are known first at their estuaries and lowlands, while their headwaters are discovered by later and more daring explorers. In Australia the chief river was first known to settlers throughout its headwaters, the discovery and exploration of the lower course and the mouth remaining as one of the most daring and adventurous acts of Australian exploration. In 1817 John Oxley explored the Lachlan, the Macquarie, and several smaller tributaries; in 1824 Alexander

[2] Colin Ross: Der unvollendete Kontinent, 6th edit., Leipzig, 1931.

Hamilton Hume discovered the upper Murray (sometimes called the Hume or the Indi); in 1831–1832 Thomas Livingstone Mitchell investigated and mapped the Namoi, the Gwydir, and the Barwon; while the "great and gentle" Charles Sturt discovered the upper Darling early in 1829 and in the same year undertook a voyage of exploration down the Murrumbidgee and the Murray to its mouth, revealing the unity of this great river system.

The state boundaries within the Murray Basin are quite meaningless from the geographical point of view. The Murray River forms the boundary line between New South Wales and Victoria, but the whole of the river was included in New South Wales, that is to say the south bank was made the boundary and not the thalweg. The remaining boundaries are mathematical lines (latitude and longitude) and have been the cause of embarrassment and litigation almost from the beginning. They were drawn up without any thought of their bearing on local problems, being considered too remote from the centers of population of the time to be of any importance. The last state boundary was fixed in 1861, when much of the interior was still unknown.

The relative areas of the Murray Basin within the different states are shown in Figure 4a, distinction being made between areas that contribute waters to the river (totaling 158,000 square miles) and the noncontributing areas of low rainfall, high porosity, and high evaporation (totaling 256,000 square miles).

Relief and Drainage

The east coast of Australia from Cape York in the north to Tasmania in the south is margined by an uplifted arcuate cordillera of block mountains. Central Australia consists of a plateau that extends practically from the north to the south of the continent. Between these two upland areas there is a series of vast depressions, constituting four more or less distinct basins.[3] The northern basin has in part been drowned by the shallow sea that forms the Gulf of Carpentaria. The large central basin has been doomed to remain an endoreic basin.[4] Streams, mainly from northerly directions, concentrate a few feet below sea level in Lake Eyre, a large *playa* lake. The two southern basins constitute the basin of the Murray, the one being that of the Darling, bounded on the south by the Broken Hill-Cobar ridge, and the other the Murray Basin proper. The ridges that almost completely surround this basin are due to uplift, and the basin itself has been relatively and positively depressed. The relief of the basin is shown in Figure 4a.

[3] Compare the map of structure and soil, Figure 1 in Griffith Taylor: The Soils of Australia in Relation to Topography and Climate, *Geogr. Rev.*, Vol. 23, 1933, pp. 108–113.

[4] See Em. de Martonne: Regions of Interior-Basin Drainage, *Geogr. Rev.*, Vol. 17, 1927, pp. 397–414; Charles Fenner: South Australia: A Geographical Study, Melbourne, 1931, pp. 63–67.

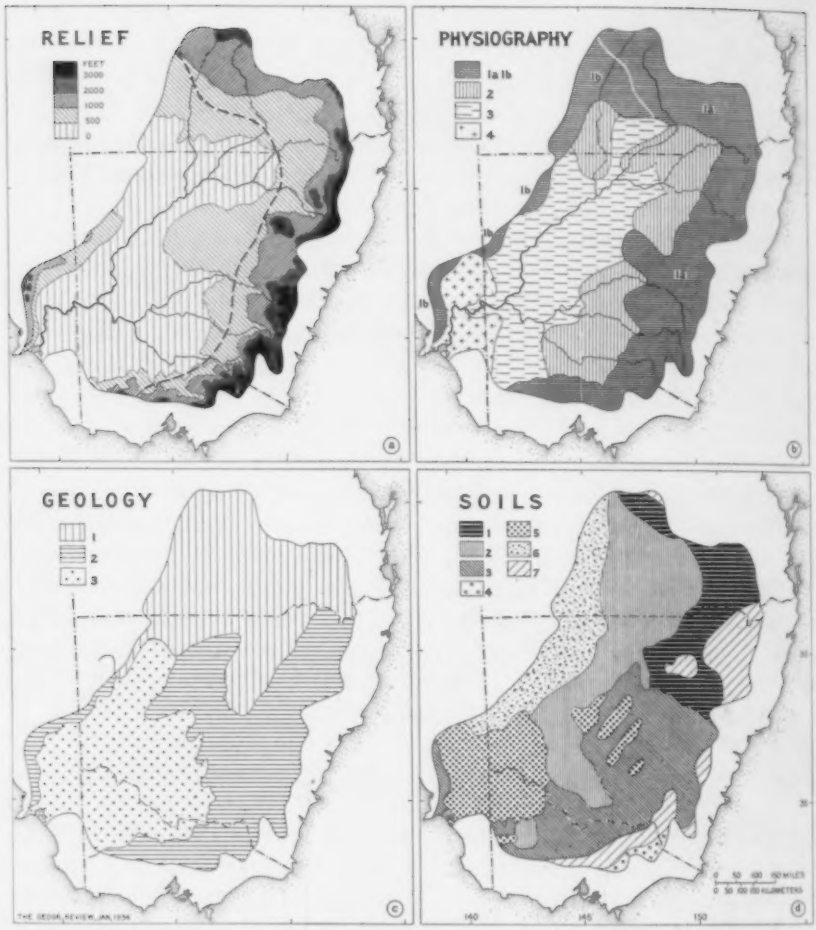

FIG. 4—Maps of the Murray Basin showing landforms, rocks, and soils. Scale 1 : 28,000,000.

On the relief map (a) the heavy broken line separates areas contributing water to the Murray system from non-contributing (areic) areas. The respective contributing and non-contributing areas (in square miles) are: Queensland, 68,000 and 37,000; New South Wales, 75,000 and 159,000; Victoria, 15,000 and 36,000; South Australia, non-contributing only, 24,000.

The physiographic map (b) distinguishes: 1, uplands; 2, *billabong* lands; 3, flat lands; 4, gorge and lacustrine and *Coorong* section of the lower Murray (below Overland Corner: for a detailed description of this section see Charles Fenner: South Australia, 1931).

The geological map (c) distinguishes: 1, Mesozoic and Eocene; 2, Granitic and Paleozoic; 3, Miocene and recent.

The soils map (d) distinguishes: 1, black earths; 2, gray and brown soils; 3, red-brown earths; 4, high moor and podsols; 5, mallee soils; 6, desert soils; 7, podsolized soils.

The physiographic evidence goes to show that the chief basin-forming movements occurred in two stages, one in late Pliocene time, a more important one in early Pleistocene. The later movements left the Darling and Murray-proper basins as two separate areas of internal drainage, but the rainfall (which was probably much heavier in the early Pleistocene) has been throughout of sufficient strength to develop both basins as exoreic areas, the Darling River joining the Murray

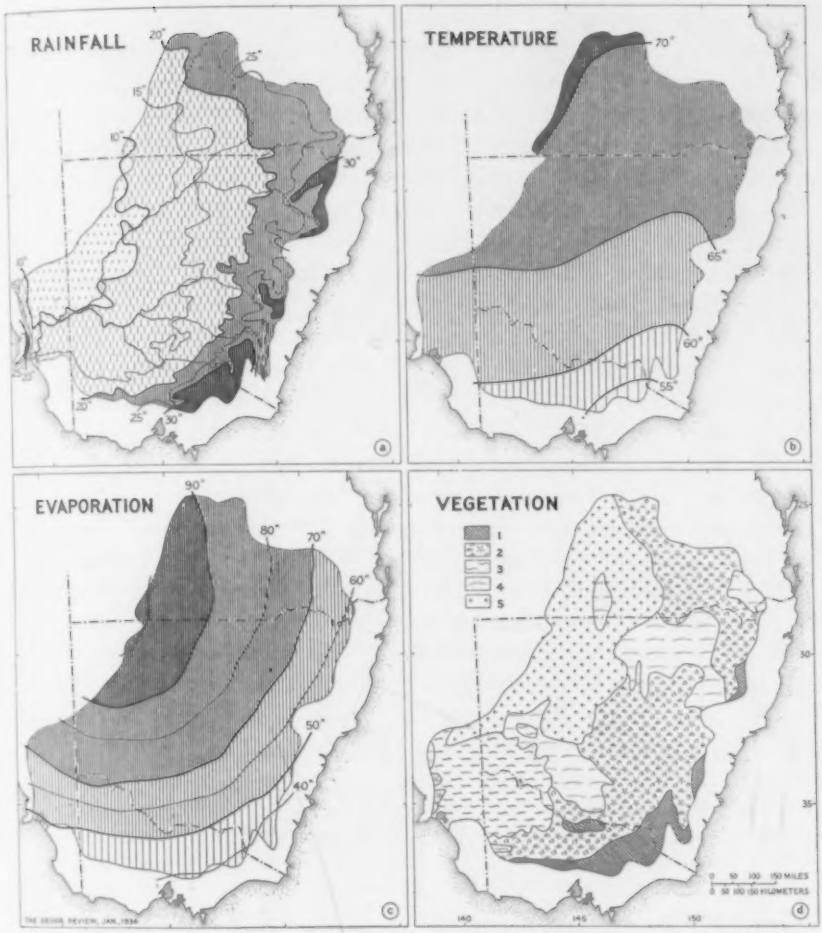

FIG. 5—Maps of the Murray Basin showing mean annual rainfall (a), temperature (b), and evaporation (c), and natural vegetation (d).

The vegetation map distinguishes: 1, sclerophyllous forest; 2, savana woodland; 3, mallee; 4, savana and Mitchell grass downs; 5, acacia semidesert shrub steppe.

River by making a passage through the Broken Hill-Cobar barrier, and the Murray cutting a gorge through gently uplifted Tertiary limestones to reach the sea. Both basins contain in their central portions vast accumulations of deltaic, lacustrine, and fluviatile gravels, silts, muds, etc.

Figure 1 shows the streams in greater detail: analysis of the stream types makes it possible to divide the area into four divisions (Fig. 4b) according to origin and history. On the northern, eastern, and southern margins there is a characteristic pluvial drainage network markedly influenced by structural and tectonic features and of the normal dendritic type (1). On the interior margin of the headwaters described above there is a broad belt of deltaic accumulations in which

rivers have developed a maze of wandering courses, branching into distributaries and billabongs (anabranches) with swamps and marshes and frequently maintaining for considerable distances a series of almost parallel courses for the same stream (2). To the west of the deltaic area are wide plains of river muds and silts. In these plains no streams have their origin. There are swamps and lakes in many places, and some wandering streams from the higher land die out here owing to the porosity of the rocks and the high rate of evaporation. The lower courses of the Wimmera and Avoca rivers in Victoria, of the Mossgiel and Sandy creeks in New South Wales, and of the Paroo and Bulloo rivers of Queensland are characteristic (3). From the South Australian border to the sea the river has a distinct character (4). From Mildura to Overland Corner (280 miles by river) is an extensive valley, averaging about six miles in width, in red and brown easily eroded lacustrine sediments, with fertile river flats much used for irrigation. From Overland Corner to the lakes and islands of the mouth there is a gorge, determined in its directions by structural features, averaging a mile in width, cutting through level-bedded marine Miocene limestones. The mouth of the river is marked by a nehrung-and-haff formation known as the Coorong—a narrow lagoon 90 miles in length, with a seaward sand bar. The estuarine lakes are characteristic of a sand-barred river mouth with many islands and silt jetties. The geographical conditions preclude a natural harbor, but engineering investigations indicate that the establishment of a satisfactory deep-sea harbor is possible.[5]

Rocks and Soils

A generalized scheme of the geology, taken from Sir Edgeworth David's geological map of Australia, appears in Figure 4c. In the north the rocks are mainly Cretaceous with some underlying Jurassic and overlying Eocene, almost everywhere level-bedded and easily eroded, providing excellent artesian water for stock purposes and, in the wetter areas, fertile soils. Most of the plains of the south-central area are made up of incoherent lacustrine muds and silts with which is incorporated much wind-borne material; they are mostly underlain by level-bedded Miocene and later limestones containing valuable artesian and subartesian water. The highlands of the east and west in the southern portion of the basin consist of resistant, highly indurated, contorted, and faulted sediments of pre-Cambrian and Paleozoic age with associated igneous rocks. They have provided fertile soils as well as rich mineral fields. Though gold production at

[5] See Major Johnston's report on a harbor for the River Murray Valley, *Parliamentary Paper No. 38*, Adelaide, 1917. Reports on the engineering and water-supply problems of the Murray Basin have been written by Messrs. H. H. Dare, A. S. Kenyon, and J. H. O. Eaton, and valuable information is contained in the "Report of the Interstate Royal Commission on the River Murray," Melbourne, 1902.

the present day has very greatly declined, two areas that rank among the greatest producers of the past lie in the mountains on the east and south of the Murray Basin. In the northeast there are tin-bearing granites; in the west is the rich silver-lead-zinc deposit of Broken Hill; the Cobar region at one time produced much copper; and in the arid northwest there are opal fields.

The soils of the basin are shown in Figure 4d, somewhat simplified from the map by Professor J. A. Prescott. In the northeast the wide plains of the Darling Downs belong to the valuable series of the black earths. The continuation of this belt towards the plain consists of red-brown earths; to the eastward the highland areas show pod-solized soils of varying character. Parallel to the black and red-brown-earth series, to the west, are vast plains of red, gray, and brown soils in the drier climatic belts. These continue to the southwest into the area classified as mallee soils, which possess characters that are peculiar to these localities. On the northwest of the basin there is a narrow margin of desert-steppe soil.

The mallee soils, established by Professor Prescott as a new soil class, are worthy of a special note and Professor Prescott has kindly written[6] the following description:

> The Mallee soils in the Murray valley are characterized by sandy to sandy-loam surface and subsurface horizons, with heavier subsoils. They vary in colour from a reddish brown to a light fawn or cocoa colour and contain calcium carbonate in a form varying from mere traces to a heavy limestone rubble or even solid travertine. The universal presence of small amounts of salt frequently gives rise to troubles under irrigation and occasionally even under dry-farming conditions. The principal controlling fertility factor is a general deficiency in soil phosphates. They are further characterized by being weakly solonized, implying the presence of significant proportions of exchangeable sodium in the reactive base complex of these soils. As may be expected from this description, the soils are predominantly alkaline in reaction and are poorly supplied with humus.

Climate and Native Vegetation

The climate of the Murray Basin is that of an interior lowland, varying from cool temperate in the south to warm temperate in the north. The northern half receives most of its rain in summer (warm monsoonal rain), while the southern half receives most of its rain in winter (cold rain from "polar-front" cyclones). The basin-shaped character of this elongated oval area, as shown in the relief map (Fig. 4a), is closely paralleled in the rainfall map (Fig. 5a). On the three highest knots of the eastern highlands—the New England Range, the Blue Mountains, and the Australian Alps—the rainfall is more than 30 inches per annum and reaches as high as 70 inches per annum. On the southeastern massif (Mt. Kosciusko and the Australian Alps) there is a fairly heavy snowfall during the winter months. The long

[6] Under date of February 6, 1933.

barrier that forms the eastern margin of the basin robs the southeast rain-bearing trade winds of much of their moisture, so that the increment of rain received by the basin from the east is not high and diminishes rapidly to the west. These interior grassland plains thus receive rain from three directions—north, south, and east—but are marginal to all three favorable influences.

The most productive belt within the area is the arc-shaped zone with a rainfall of 20 to 30 inches per annum; here we have cattle, sheep, wheat, orchards, and dairying. Almost the whole of the purely plains area receives a rainfall of between 10 and 20 inches per annum and is dominantly pastoral, with wheat in the cooler south and with irrigation in selected areas along the southern rivers. The portion that receives less than 10 inches, in the west, has a sparse pastoral population, but some rich mineral deposits occur here.

As far as the general weather conditions are concerned, the climate of the whole basin is an equable one. Outdoor life is possible throughout the whole year, though in the northern and western portions the summers are hot. Even there, however, the nights are cold. The winters are everywhere mild and pleasant. In the south the average annual temperature is about 60° F., varying in the north to an average just over 70°. As elsewhere, the direction of the wind largely determines the temperature and humidity and has more influence on personal comfort than any other single factor.

The annual evaporation is very high in the northwestern portion of the basin (Fig. 5c), being well over 90 inches per annum from a free-water surface. It is only in isolated, marginal highland areas that the annual evaporation is equal to or less than the annual rainfall. The evaporation arcs are concentric, as in the rainfall map, but they surround a center somewhat farther to the north than do the isohyets. Three-quarters of the Murray Basin, comprising the central, northern, and western parts, have an evaporation of more than 60 inches per annum. This has an important influence on water conservation, river flow, and plant and animal life generally. Most of the flora is of markedly xerophytic habit.

The most important index to the climatic conditions that have prevailed in the Murray River Basin during recent time is found in the native vegetation, of which a simplified map is shown in Figure 5d. The sclerophyllous forests of eucalypts, which are the chief timber areas of the states, are found only on the highlands marginal to the east and south, with the exception of a small area of densely wooded flats on the Murray River. The western slopes of the highlands, which are the best-watered and most fertile areas, have a native vegetation of savana woodland, broken in three or four places by vast open Mitchell-grass (*Astrebla*) plains with occasional trees. In the southwest this gives place to the dwarf eucalypt scrub known as the mallee.

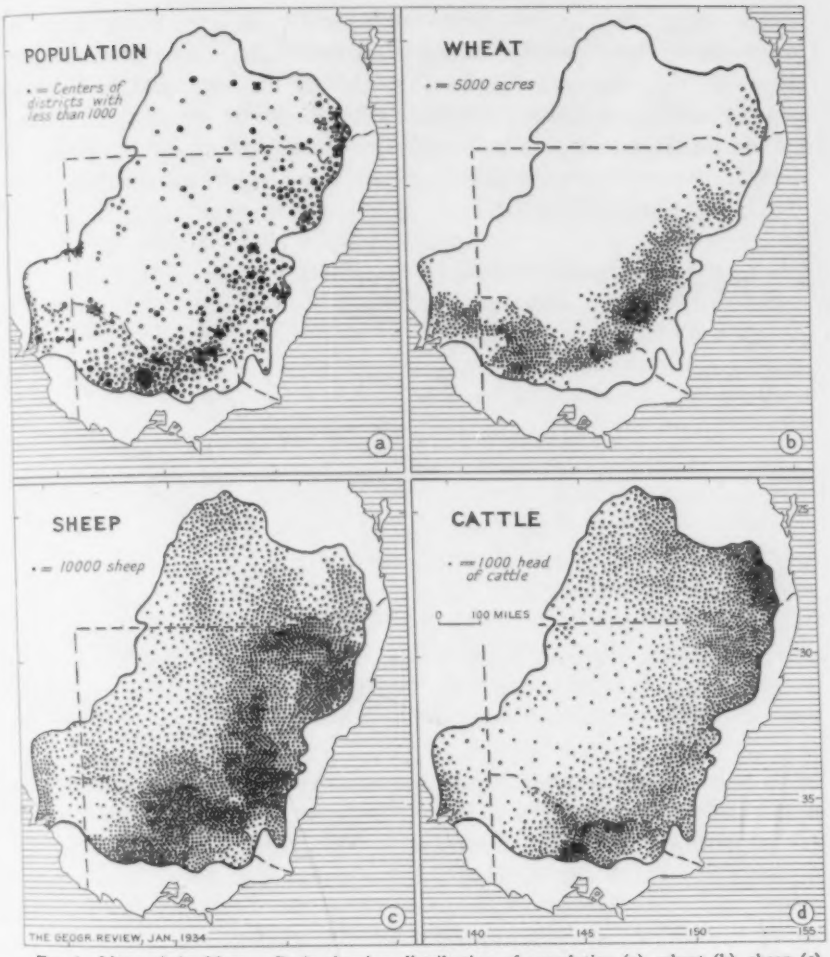

FIG. 6—Maps of the Murray Basin showing distribution of population (a), wheat (b), sheep (c), and cattle (d).

The northwest semidesert plains have for the most part mulga (*Acacia aneura*), brigalow (*Acacia harpophylla*), and saltbush (*Atriplex* and *Kochia*) suites of plants. This is classified as "acacia-shrub steppe" and has no more than a low pastoral value.

LAND UTILIZATION

In the whole vast area of the Murray Basin there are no manufacturing towns whatever. Here and there we may find a small isolated flour mill or knitting mill or agricultural-implement factory, but such efforts are local and unimportant. The basin of the Murray River is an area devoted to primary productions.

The map of population distribution (Fig. 6a) shows that the whole

area is occupied. On the whole, the densely populated areas lie on the low uplands—the western slopes of New South Wales, the northern slopes of Victoria, and the Darling Downs of Queensland—between 500 feet and 1000 feet. This area is for the most part a mature land carved out in a complex and varied series of Paleozoic rocks. It has a well developed exoreic drainage system, a rainfall averaging from

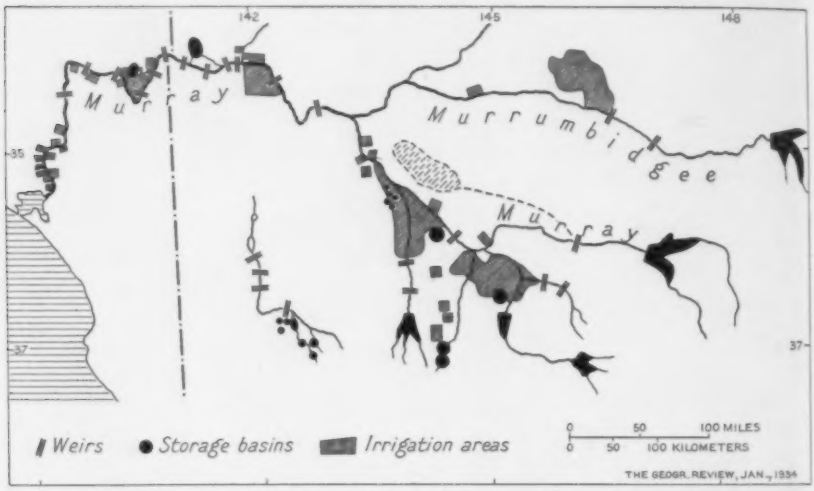

FIG. 7—The southern portion of the Murray Basin showing weirs and storage basins and irrigation areas.

20 to 30 inches per annum, a general native vegetation of savana woodland, and soils varying from black earths in the north to red-brown earths in the south. The central and western plains are but sparsely populated. There are, however, three areas of greater density—the important mining center of Broken Hill on the western margin of the basin, the irrigation areas along the lower portions of the Murray and Murrumbidgee rivers, and the wheat-growing areas of the mallee.

The sheep map of the Murray Basin indicates that wool is the most significant of all its productions. The basin is in fact one of the notable wool-producing areas of the world, from the point of view of quality as well as of quantity. The density accords closely with that of the population. The sparser areas on the sheep map are due mainly to rugged highlands or semiarid steppe conditions or the mallee wheat.

The distribution of cattle, like that of sheep and population, is densest around the eastern and southern margins, but there is a greater concentration of cattle towards the warmer north as compared with the greater concentration of sheep towards the cooler south. If distinction were made between beef and dairy cattle, it would show the former more numerous towards the north, the latter more numerous towards the south. The wide, dry plains of the interior carry fewer cattle and sheep than is popularly supposed.

The boundary of the wheat area inland is very definite and corresponds closely with the line of eight inches of average rainfall during the growing season. The wheat is largely confined to the lower and more level country. In the south little is grown above 1000 feet, but in the north wheat is grown at much higher altitudes, as is shown by the maps. At present the production of wheat is extending both in the mallee areas in the south and in the Darling Downs in the north.

Among other crops there is a considerable amount of hay grown; also oats, barley, and potatoes. On the eastern and northern slopes, particularly around the larger centers of population, there are much fruit growing, dairying, and poultry farming. During recent years two new crops have made their appearance in this area—rice and tobacco. The rice grown on the Murrumbidgee irrigation areas is already more than sufficient for Australian requirements.

It is obvious from the factors of climate, relief, soils, and water supply that in the south-central portion of the Murray Basin the stage is set for a fairly extensive development of irrigation. Victoria was the first state to take up irrigation seriously and has always led the way. The reason is not quite clear: it may be due to the wisdom and vision of the statesman, Alfred Deakin; to the enterprise and courage of certain Americans, notably the Chaffey brothers and Elwood Mead; to the fact that the population pressure was greater in Victoria and the Murray waters are nearer to the capital city; to the more invigorating climate of the southern mainland state; or to a combination of all these factors.

South Australia has done valuable work in the endeavor adequately to utilize the irrigable land within the narrow valley of the lower Murray in that state. A great impetus was given to the movement in New South Wales by the construction of the huge Burrinjuck dam on the Murrumbidgee. The post-war problems of soldier settlement caused a speeding up in the development of irrigation schemes in all the states. The federal commission that now controls the waters of the Murray Basin has done much towards the proper conservation of the precious waters of these rivers, particularly in the building of a fine series of weirs at intervals along the rivers, the carrying out of the Lake Victoria storage scheme, and the building of the Hume dam on the upper Murray, above Albury. Figure 7, compiled by courtesy of the irrigation authorities of the three states, shows the distribution of the storage basins and the irrigation areas at the present time. In addition there are still larger areas in Victoria and New South Wales that have extensive systems of water supply for stock and domestic purposes. On the irrigation areas the chief plants are vines, citrous trees, and stone fruits—for the production of raisins, currants, oranges, lemons, apricots, etc.—but rice and other lesser crops are also successfully grown.

CLIMATIC YEARS

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CLIMATE, as ordinarily considered, implies long experience. With reference to a particular place, it is usually expressed in the form of statistical averages and departures. These may be fitted into quantitative definitions and thus be used to outline climates in the distributional sense. The climatologist interested in this phase of the subject usually tries to delimit regions on the basis of records extending back through the greatest possible number of years. In doing so he tacitly assumes a fixity of climatic boundaries that is open to question.

Climatic Boundaries

Climates are ordinarily predicated on the distribution of such things as land forms, soil, drainage, animal life, vegetation, and culture. Nuclear conditions are recognized, and correlations with meteorological experience are attempted. While climax climatic landscapes may be sufficiently distinctive to warrant recognition, all the forms involved normally display rather gradual geographical variations from one to the next. On a climatic map the boundaries between climax landscapes are ordinarily represented by lines placed medially within transitional zones.

The substitution of a cartographic line for a transitional zone in nature should be clearly understood. For example, if we seek the climate of Rapid City, S. Dak., on the climatic map of North America by Thornthwaite,[1] we may have difficulty in determining its precise classification according to the method of climatic differentiation used. We have no trouble, however, in finding that it is located in a region where the transition from semiarid to humid conditions occurs within a very few miles, that it lies well within the microthermal temperature province, and that no particular season is markedly drier than another. This is the type of information obtainable and is as detailed as we can reasonably expect from the source under consideration. Our climatic picture is sufficiently well drawn. No particularly useful purpose would have been served had we taken proportional dividers and determined that Rapid City fell within the field of the climatic type designated number 20 on the map. It is more significant to know that the temperatures of Prescott, Ariz., place it practically on the mesothermal-microthermal boundary than it is to know precisely whether the station is mesothermal or microthermal. There is real merit in the omission on climatic maps of a detailed grid or other

[1] C. W. Thornthwaite: Climates of North America, *Geogr. Rev.*, Vol. 21, 1931, Pl. 3.

means for the close identification of boundary positions, for the reason that the reader is thereby more or less forced to recognize boundaries as transitional zones.

While theoretical reasons possibly exist for the recognition of climax climatic landscapes in terms of very small areas, thereby leaving most of the earth's surface within transitional zones, the ends of geographical inquiry are better served by the adoption of climatic definitions sufficiently broad and flexible to admit more extensive type regions and narrower transitions. Such climatic concepts as tropical rain forest, tropical savana, steppe, or desert readily call to mind characteristic scenes in which it is well to allow fair amounts of variation. A desert extending rather widely over territory incapable of supporting any considerable population without artificial water supply and almost destitute of vegetation is more significant than is one restricted to such places as receive no precipitation whatever.

If we assume that gradual transitions in nature, here and there, encounter important critical limits, it is clearly these we seek in climatic definitions. If these limits are inconstant in position from one year to the next, we have the reason why climatic boundaries are transitional zones. From this viewpoint it becomes relatively simple not only to draw climatic boundaries but also to delimit transitional zones and thereby establish nuclear regions of climax climatic landscapes.

The Climatic-Year Concept

The validity of the assumption that climatic landscapes are fixed in position, even within relatively short periods of time, has been questioned by the writer.[2] Proposing the concepts *desert year* and *steppe year*, he suggested that the recurrence of either most likely has greater significance in landscape than has any thermohyetal mean based on a long period of observation. We may now extend the *climatic-year* concept to include humid climates. In any quantitative definition of a climate we may substitute the meteorological values of a single year for the normals assumed by the original and call the result a *climatic year*. If, for example, we adopt Köppen's definition for tropical climates, we shall then regard any place, irrespective of location or the experience of other places in its vicinity, as having had a *tropical year* if it has experienced a *humid year* with all monthly mean temperatures in excess of 18° C. (64.4° F.). If a certain precipitation deficiency, either of a single season or of the year as a whole, is an added condition in the definition of a tropical-savana climate, then an individual year meeting the requirement may be called a *tropical-savana year*.

[2] R. J. Russell: Dry Climates of the United States: II, Frequency of Dry and Desert Years 1901–30, *Univ. of California Publs. in Geogr.*, Vol. 5, No. 5, Berkeley, 1932, pp. 245–274.

The climatic-year concept furnishes a simple and apparently satisfactory means for the determination of climatic boundary zones. We may recognize as transitional any region that normally experiences a recurrence of climatic years typical of nuclear climates on either side. Thus the transitional zone between rain forest and savana is the region ordinarily experiencing both rain-forest and savana years. The nuclear rain forest, on one side, is characterized by an unbroken succession of rain-forest years, while, on the other side, only savana years occur.

The climatic-year concept furnishes also a basis for the recognition of climatic boundaries depending on fundamental relationships between landscape and climate. The area experiencing a given type of climatic year, for example, mediterranean, will never be the same in different calendar years. We may think of mediterranean climate as inconstant in position, at times advancing over large regions, at others retreating, sometimes by long abrupt leaps, often by inconsequential shifts from one year to the next. Secular changes, though frequently reversed or interrupted, may effectively widen or circumscribe its range in the course of millenniums or within cycles of comparatively brief duration.

Meanwhile the landscape undergoes adjustments to the ever changing climatic conditions. Its forms respond at varying rates, some more rapidly than others. Individually they seek equilibrium but reach it only after sufficiently long periods of stability have elapsed. Where a succession of many mediterranean years permits complete, or nearly complete, equilibrium, we find a typical mediterranean landscape. In bordering transitional zones the landscape forms incline first toward one, then the other, equilibrium. If new plants establish themselves more rapidly than new land forms, we may see, especially in transitional zones, hybrid landscapes, in which such combinations occur as xerophytic steppe plants on mediterranean topography. This should be the fundamental basis on which climatic boundary lines are to be drawn. The nuclear mediterranean climate experiences none but mediterranean years and exhibits a pure mediterranean landscape, with permissible variations in individual forms. Passing outward toward an adjacent climate, we first encounter rather insignificant changes where the frequency of mediterranean years begins to fall below an effective 100 per cent, but these changes become more striking and diverse as we advance, until, ultimately, we reach the nuclear portion of the next climate, with its own climax landscape. We may regard a climatic-year frequency of 50 per cent as the boundary between climates and thus divide the transitional zone between them.

Climates have meaning in time as well as in space. If geography concerns itself chiefly with today's landscapes, it is likewise interested

in the climates of recent years to the extent that they have affected landscapes. But different geographical inquiries will be interested in different time intervals. If there be any real value in distributional climatology, it seems apparent that the economic geographer will find annual and decennial climatic-year maps of greater significance than mere statements of mean values for individual climatic elements such as rainfall and temperature. For many of his purposes the climatography of the past decade is more significant than one based on the meteorological normals of a century. The student of successive landscapes may require a successional climatology involving a whole series of climatographies, each based on possibly less than twenty-year periods. As we dissect the landscape into its component groups of forms, we find that individually these demand longer or shorter periods for the reason that they travel toward equilibriums at differing rates. During a twenty-year interval, ten desert years—occurring as a rather unusual experience in terms of the events of the past century—probably alter vegetation much more than land, drainage, or soil forms. A regional climatology, *per se*, should be based on a record extending back through recent years only far enough to differentiate landscapes in terms of their most characteristic nuclear forms.

The Unusual Experience

While it is the custom to erase the unusual experience from the climatic record by the device of obscuration in long averages, the testimony of the landscape suggests that we should treat it quite differently. If an unusual experience is expressed in landscape, it possibly deserves to be emphasized rather than to be smoothed away. The effect of floods may serve as an example. Few landscapes, whether humid or arid, are free from the scars of high or violently flowing waters. Precipitation averages mean little to the geomorphologist in comparison with the record downpours of one or more intense storms. The changes accomplished during a single flood often overshadow the normal erosion of many succeeding decades. In such cases a climatology of extremes is more significant than one based on normals. On the other hand, many unusual experiences are not expressed in landscape—at least for significant periods of time. Mature plants are less likely to succumb to the vicissitudes of climate than are young ones. Though an occasional desert or tundra year may upset vegetational balances temporarily, recurrence at such a rate as once a century very likely has little bearing on the distribution of forest or grassland. Yet, if the recurrence is so frequent that individual plants are prevented time after time from reaching sufficient maturity to withstand such extremes, it becomes highly significant. The westward extent of forest toward the Great Plains of the United States is

more probably related to the recurrence of desert years than it is to the distribution of normal precipitation. While some unusual experiences deserve emphasis in certain climatic studies, others should be deleted from the records rather than averaged into normals.

Unusual experience has the effect of widening transitional zones at the expense of nuclear climates. This is true in both fact and theory. Under the criteria here proposed for the recognition of transitional zones it is evident that, on the average, those zones based on the records of a century will be wider than those based on the records of a decade, for the reason that a greater number of unusual experiences will have occurred during the longer interval. If our desideratum is a climatic transitional zone agreeing with a landscape transitional zone, we should completely disregard unusual climatic experiences unexpressed in landscape. This may be done effectively by means of drawing climatic boundaries as based on the records of comparatively short periods, disregarding any very exceptional features they may contain. Thus we might map the frequency of mediterranean and steppe years on the basis of the past decade, omitting from consideration any year that happened to be the wettest, driest, coldest, or hottest during the past half century, in order to find a satisfactory mediterranean-steppe boundary and a significant transitional belt between the two climates.

The use of short intervals for climatic mapping tends to render climatic distribution inconstant in position depending on the particular group of years considered. The extent of territory in the United States experiencing one or more desert years was considerably greater in the second than in the first decade of the present century. This, however, does not constitute a valid objection to the use of short records. Climates are not constant in position, and it is fallacious to regard them as being so. The geographical significance of any given climate varies in the course of time. For many purposes the distribution of desert years during the second decade of the present century is decidedly more significant than the average distribution during the past century.

A Mesothermal-Year Map of the United States

Practically all systems of climatic classification recognize in the United States temperature contrasts sufficiently pronounced to justify the placing of part of Florida within tropical climates and some of the higher mountain summits within tundra climates. Between these extremes two temperature provinces are ordinarily recognized and are designated warm and cool temperate, mesothermal and microthermal, or in some similar manner. Between these four major belts are three transitional zones. We must drop one of these—the transi-

tion between microthermal and tundra temperature belts—from consideration at present because of the scarcity of records. Fortunately this is the transition of least significance, because it occurs only in mountains where the relief is abrupt and the zone narrow. The two other transitional belts flank mesothermal climates on one side, thus a study of mesothermal-year frequency outlines them both.

Tropical climates have been bounded by Köppen[3] on the basis of a coldest-month mean temperature in excess of 18° C. (64.4° F.). This definition is apparently quite satisfactory. Thornthwaite uses somewhat different criteria for the definition but arrives at essentially the same cartographic conclusion.[4]

The boundary between mesothermal and microthermal climates is less certain, if we are to judge by the differences of opinion as to its location.[5] Boundaries from north of Milwaukee to south of Memphis have been proposed, but the writer considers St. Louis and Cincinnati as more closely approximating the boundary demanded by both natural and cultural landscapes and has urged the adoption of the January-mean isotherm of 32° F. as the simplest and nearest approximation to the climatic definition.[6] This identical line is employed by Miss Semple[7] for the same boundary in Europe.

Using the very simple definition that a mesothermal year is one in which the mean temperature of January falls between 64.4° F. and

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[3] W. Köppen: Versuch einer Klassifikation der Klimate, vorzugsweise nach ihren Beziehungen zur Pflanzenwelt, *Geogr. Zeitschr.*, Vol. 6, 1900, pp. 593–611 and 657–679; *idem:* Versuch einer Klassifikation der Klimate, vorzugsweise nach ihren Beziehungen zur Pflanzenwelt, *Meteorol. Zeitschr.*, Vol. 18, 1901, pp. 106–120; and in subsequent papers.

[4] W. Köppen and R. Geiger: Klimakarte der Erde, 1 : 20,000,000, Gotha, 1928. Köppen's limit for tropical climates is a few miles farther north in Florida. The agreement is almost exact on the Gulf coast of Mexico and across the mainland. On the west coast Köppen extends tropical climates as far north as northern Sinaloa, but Thornthwaite extends them well along the coast of Sonora. Köppen considers La Paz and the southern tip of Baja California as tropical, but Thornthwaite maps that region as mesothermal and arid.

[5] Köppen (Versuch einer Klassifikation der Klimate, 1901, p. 118) defines microthermal climates on the basis of a warmest-month mean temperature above 10° C. but not above 22° C. and a coldest-month below 6° C., thus placing the line farther north of the United States than would be the case even if 0° C. were substituted for 6° C. In his "Klassifikation der Klimate nach Temperatur, Niederschlag und Jahreslauf" (*Petermanns Mitt.*, Vol. 64, 1918, pp. 193–203 and 243–248) the southern boundary of microthermal climate is placed along the isopleth of –3° C. for the coldest month, which moves it farther south, but not so far, in the United States, as is shown on the map accompanying R. DeC. Ward: A New Classification of Climates, *Geogr. Rev.*, Vol. 8, 1919, pp. 188–191. More accurate is the boundary as mapped by W. Van Royen (The Climatic Regions of North America, *Monthly Weather Rev.*, Vol. 55, 1927, pp. 315–319). This map shows the boundary in central Illinois, as demanded by the –3° C. definition. Adopting the definition "at least one month between 10° C. and 18° C. and at least four months below 1° C.," Köppen again shifts the boundary northward on the Köppen-Geiger Klimakarte. The equivalent boundary on Thornthwaite's map approximates the –1° C. and –2° C. cold-month isotherms in the central United States but lies nearer 1° C. on the Atlantic coast. A similar boundary on Glenn T. Trewartha's map in his "Climates of the World," 1929, lies somewhat south of any of the above.

[6] R. J. Russell: Climates of California, *Univ. of California Publs. in Geogr.*, Vol. 2, No. 4, Berkeley, 1926, pp. 73–84. The writer suggests 32° F. on evidence of California landscapes and advances the opinion that the same line separates the most significant temperature provinces in dry climates. These ideas are elaborated and supported by evidence from practically every field of geographical inquiry in his "Dry Climates of the United States: I, Climatic Map," *ibid.*, Vol. 5, No. 1, Berkeley, 1931, pp. 1–41; reference on pp. 26–38. An additional argument, based on land forms, is presented in *Science*, Vol. 74 (N.S.), 1931, pp. 484–485.

[7] E. C. Semple: The Geography of the Mediterranean Region, New York, 1931, p. 222.

32° F., the distribution of three of the four major temperature provinces of the United States, with transitional zones, during the years 1914–1931 is shown in Figure 1. Southernmost, in the Florida Keys region, is the northern limit of the region recording only tropical years, i.e. nuclear tropical climates. In southern Florida the solid line repre-

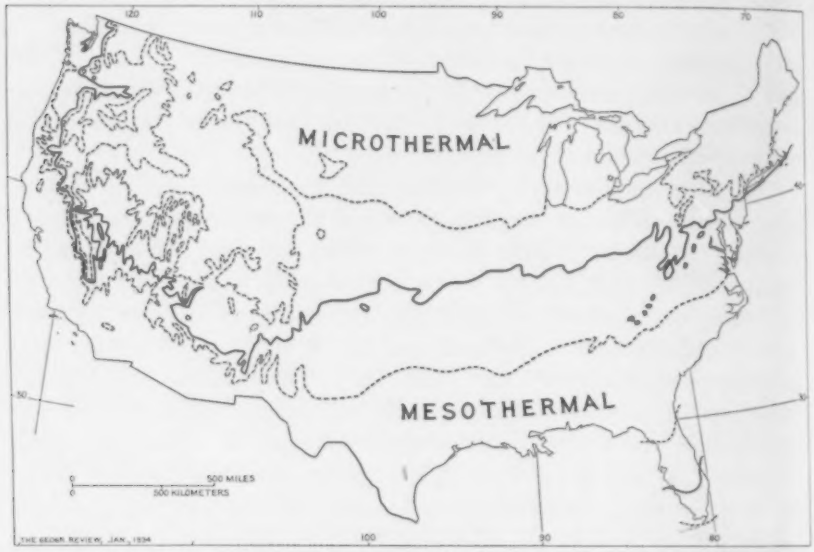

FIG. 1—Mesothermal-year frequency in the United States, 1914–1931. Southernmost lies the nuclear tropical climate, northernmost the nuclear microthermal. Major climatic boundaries are solid lines; the limits of transitional zones are dashed. The construction of the map may be described as follows: An examination of climatological data for 1914 disclosed 1898 stations suspected of lying within or near the transitional zones on either side of the mesothermal climatic zone. January temperatures were recorded and climatic years classified for each of these stations up to and including 1931. Perfect records were obtained for 841 stations, and these became the main basis for the map. Stations with more than five incomplete years were discarded. Temperature estimates were introduced for other stations, the basis of estimate being the recorded temperature of the nearest station having most similar January temperatures in other years. If any estimated temperature fell within 2° F. of either critical value (64.4° F. or 32° F.), the station was discarded. In all, 606 estimated temperatures were supplied for 333 stations. Thus the map was actually drawn on the basis of 21,132 mean-temperature records from 1174 stations, and it is improbable that any errors introduced in estimating temperatures bear on the accuracy of the final result. The distribution of stations (a map showing distribution of the stations is on file at the American Geographical Society) is by no means uniform. The least satisfactory records and spacing of stations were found in California, where of 54 stations selected in 1914 only 8 had perfect records for the entire period. Indiana, on the other hand, supplied 34 perfect records out of 49 stations selected at the start of the study. Iowa, Missouri, and Arkansas were mapped wholly on the basis of perfect records. Isopleths were drawn on trial maps on all frequencies, 0 to 18, of mesothermal years. These were later adjusted to topography, and only those here regarded as major boundaries and limits of transitional zones are reproduced.

sents a mesothermal-year frequency of 50 per cent, i.e. the major boundary between tropical and mesothermal climates. Farther north the dashed line marks the northern limit of places that experienced one or more tropical years, i.e. the southern limit of nuclear mesothermal climates. In a similar manner the transition between mesothermal and microthermal climates is shown still farther north.

In many respects the most important temperature boundary in

the United States is that between mesothermal and microthermal climates, with its extension across the dry climates, where it separates them into mild and cold temperature types. While the January-mean isotherm of 32° F. is a highly satisfactory expression of this boundary, a mesothermal-year frequency of 50 per cent is equally so, because the two lines are practically identical. In both cases they meet the cultural requirements of separating New England from the mid-Atlantic states, the intensively farmed central states from the South, the brick and stone houses in the dry climates from the wooden and adobe structures in the realm of Mexican influence, and the highland pastures from the forested and agricultural lands of the Far West. As shown in Figure 1, this line conforms exactly to all station records—a fact that introduces certain apparently fictitious irregularities, such as a northward swing in Kansas. It is desirable that a boundary of this kind be smoothed and that certain exotic records be disregarded, but only after the general acceptance of the principles upon which the line has been based. Smoothing this boundary in the present case would deny the reader a fair appraisal of the scheme under consideration. It is easy enough for him to introduce modifications he deems desirable.

The Transitional Belts

The mesothermal-microthermal transition narrows in regions of sharp relief, as in the southern Sierra Nevadas and in southwestern Utah. It also narrows toward continental margins, reflecting the moderating influence of oceans on temperatures, and notably widens in continental interiors. The somewhat astonishing arm across Wyoming and scattered patches of transitional territory in Montana direct attention to an extremely interesting climatic condition. Twelve stations of the group considered in Montana experienced one or more mesothermal years between 1914 and 1931. Seven of these experienced more than one, and four stations recorded more than two. As the January cold pole of the United States lies, on the average, not many miles eastward, we have here an emphatic illustration of the climatic variability of the interior of a continent. This variability involves the extreme ranges between high and low temperatures not only in the course of a year[8] but also between one year and the next. The January mean temperature at Bigtimber, Mont., rose to 32° F. or higher (37° F. in 1919) in four of the eighteen years of the study, yet it sank to 5° F. in 1916 and to 8° F. in 1930.

It might be suspected that the extraordinary extension of the transitional belt into what is ordinarily a nucleus of microthermal conditions in Montana and other irregularities on the frequency map reflect a fault in the climatic definitions here used in that they depend

[8] Miles City, Mont., has officially recorded a highest temperature of 177° F. above its lowest temperature.

on January rather than on coldest-month temperatures. It is true that mesothermal-year frequencies would here and there be cut slightly if coldest-month temperatures were used, but the changes would be unimportant. Practically every Montana station reporting a mesothermal year under the January definition would continue to do so under a coldest-month definition. January is ordinarily the coldest month in the continental interior. In southwestern Montana 20 stations report a January minimum temperature to 4 reporting a February minimum. Whereas January minima ordinarily are well below February temperatures, all February minima are but very slightly lower than January temperatures. Thus the distinction is pedantic in Montana. It is chiefly in the Great Lakes region and eastward that the coldest month is most likely not to be January, but an inspection of records will show that, as in Montana, December and February minima seldom fall far below January temperatures. In the case of the present study, the substitution of coldest-month for January temperatures happens to have almost no effect for the reason that almost the whole region that experiences December or February minima lies within nuclear microthermal climates.

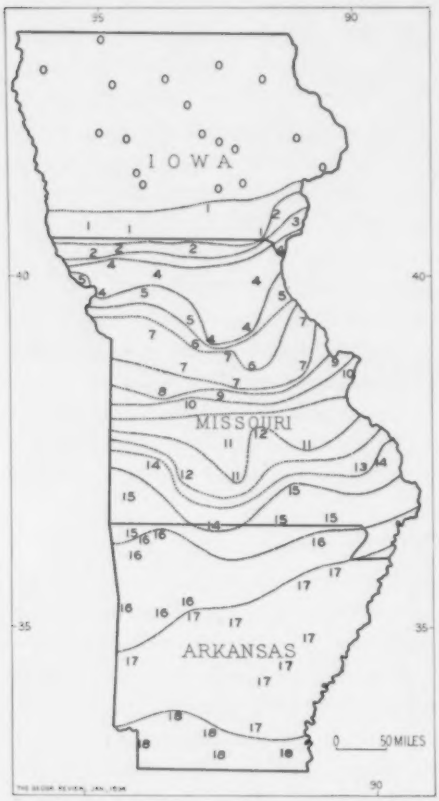

FIG. 2—Isopleths of each annual frequency of mesothermal years 1914 to 1931 across the relatively flat states of Iowa, Missouri, and Arkansas. This is the entire transitional belt between mesothermal climates, on the south, and microthermal climates, on the north.

The comparatively regular southern boundary of the transitional belt between mesothermal and microthermal climates reflects in part less rugged relief than happens to occur along the northern boundary, but it also reflects greater stability of temperatures toward lower latitudes. Excepting a few rather gentle sinuosities, almost every irregularity along the line is the direct result of relief.

Somewhat more than half of the transitional belt to microthermal climates falls within mesothermal limits. This is indicated in a general

way in Figure 1 but more significantly in Figure 2, which shows isopleths of each annual frequency of mesothermal years across the whole transitional belt in a relatively flat region. There is a distinct grouping of isopleths toward the frequency of 50 per cent, here recognized as the climatic boundary itself.

The mesothermal-tropical boundary crosses Florida some three-quarters of the distance toward the southern end of the peninsula. Tropical years occur at least as far north as Cedar Keys, on the Gulf coast, and St. Augustine, on the Atlantic. No station on the mainland recorded a frequency of tropical years of 100 per cent, though several came close—Fort Lauderdale and Hypoluxo with 16 out of 18, and Miami with 15. Both Key West and Sand Key recorded all tropical years: thus the entire transition between mesothermal and tropical climates occurs within the territorial limits of the United States, though the sample is small. The relatively narrow latitudinal width of this belt, as compared with that of the mesothermal-microthermal transition, should not be considered a characteristic. It is here narrow because Florida lacks longitudinal width and therefore the moderating influences of ocean and gulf are pronounced. On the immediate Atlantic seaboard itself it is wider than the northern transitional zone, and it is reasonable to suppose that it ordinarily becomes a very much wider zone across continental interiors.

If absolute climatic-year purity is required of nuclear climates, the United States from 1914 to 1931 had but one completely mesothermal state—Louisiana. South Carolina missed the distinction by only a very small margin. Six states—North Dakota, Minnesota, Wisconsin, Vermont, New Hampshire, and Maine—were completely microthermal. Michigan had only a small transitional area. A belt about 350 miles in width separated nuclear tropical from nuclear mesothermal climate, and, in reasonably flat territory, the latter was separated from nuclear microthermal climates by a 450-mile zone. To the writer these widths of transitional zones seem reasonable in the light of striking differences between the nuclear landscapes that they separate. Their positions appear satisfactory in terms of transitional landscape forms. Thus the criteria of definition seem valid.

Some Correlations

It is interesting to note certain relationships between the temperature belts predicated on the basis of climatic-year frequency, as represented in Figure 1, and distributional phenomena classified according to entirely different standards. In many ways the agreement with Merriam's[9] life regions is striking. The northern boundary of tropical

[9] C. Hart Merriam: Life Zones and Crop Zones of the United States, *U. S. Dept. of Agric., Biological Survey Bull. No. 10*, Washington, 1898. The discussion in the present paper is based on the fourth edition of the map as presented in Isaiah Bowman: Forest Physiography, New York and London, 1911, and in J. Paul Goode: Goode's School Atlas, New York, 1932, p. 47.

climates is practically identical with that of the corresponding life region. The northern boundary of nuclear mesothermal climates agrees with the northern boundary of the Lower Austral zone on the Atlantic coast and remains very similar as traced westward to the vicinity of the Pacific coast, where cool summer temperatures lower all life regions, both in elevation and in latitude. Again excepting the Far West, the southern boundary of nuclear microthermal climates closely approximates the northern boundary of the Upper Austral zone. They reach approximately the same eastern point on Lake Ontario, and both show the same striking tendencies to extend into Montana and to include on their warmer sides a considerable part of Nevada and the lava plateau regions of Idaho, eastern Oregon exclusive of the Blue Mountains, and eastern Washington. Thus the whole region here considered as transitional between mesothermal and microthermal temperature provinces agrees rather strikingly with the Upper Austral life region.

It could hardly be expected that belts defined on the basis of cold-season temperatures, excluding humidity and precipitation values from all consideration, should outline regions of vegetational similarity. East of the Mississippi River, however, precipitation is normally adequate at all seasons, and the relative importance of temperature in the determination of distributional limits is greater. Here several striking correlations exist. The birch-beech-maple-hemlock association of the northeastern United States is closely restricted to nuclear microthermal climates.[10] The oak-hickory and chestnut-chestnut oak-yellow poplar forests cover most of the mesothermal-microthermal transitional zone, the boundary agreement being strikingly close on the south, less so on the north, where the former association overlaps nuclear microthermal climates westward. The northern boundary of the oak-pine association of the southern hardwood forest agrees closely with the northern boundary of nuclear mesothermal climates east of Mississippi. The cypress-tupelo-red gum, river-bottom forest reaches its northernmost point on the Wabash at approximately the mesothermal-microthermal boundary.

Turning now to cultural landscapes, which in many cases are even better tests of climatic definitions than are forms of natural landscapes, the hay-and-dairy region of the northeastern states is almost precisely the region of nuclear microthermal climates.[11] The Corn Belt is outlined on the north by the limit of the mesothermal-microthermal transitional zone in the Great Lakes region, but westward it extends somewhat north of that zone. Southward it stops almost

[10] The discussion is based on H. L. Shantz and Raphael Zon: Atlas of American Agriculture, Part 1, Sect. E, Natural Vegetation, Washington, 1924.

[11] The agricultural regions here considered are those of O. E. Baker: A Graphic Summary of American Agriculture Based Largely on the Census, *U. S. Dept. of Agric. Miscellaneous Publ. No. 105*, 1931. Correlations with individual crops are striking in many cases.

exactly on the mesothermal-microthermal boundary. The Corn and Winter-Wheat Belt extends southward to about the northern boundary of nuclear mesothermal climates, precisely so east of the state of Mississippi, but westward the alluvial soils along river bottoms allow the Cotton Belt to thrust northward so that in places it transgresses the mesothermal part of the transitional belt almost half of the distance to the major climatic boundary.

Conclusions

It is felt that the climatic-year concept opens up many new and fruitful possibilities in climatological research. It may be adapted for use with any type of quantitative climatic definition. Used in connection with short periods of observation it furnishes a sensitive index of climatic change, for example, between one year and the next or between one small group of years and another. It offers the possibility of studying climatic cycles in terms of areal distribution. Through the employment of differing periods it suggests the possibility of measuring relative rates of change between various groups of landscape forms in response to climatic conditions. As here presented it provides a method for the delineation of the boundaries of nuclear climates and of transitional zones. Possibly most fundamental of all, it frees us from the blind assumption that landscape forms are related chiefly to normal climatic conditions.

The validity of the climatic-year concept does not rest upon the soundness of the frequency map presented here. If the map is deemed satisfactory in its division of the United States into nuclear and transitional temperature belts, it pays tribute to Köppen, who has championed the recognition of climatic types on the basis of such simple criteria as cold-month mean temperatures.

AN ESKIMO DISCOVERY OF AN ISLAND NORTH OF ALASKA*

Vilhjalmur Stefansson

FIG. 1—The Eskimo sloop, *Takpuk*, at Takpuk's island.

In September, 1931, the 10-ton power sloop *Takpuk* under command of her owner of the same name and with a crew of seven or eight—captain and crew all Eskimos—was searching for whales north of Alaska somewhere off the coastal fringe of islands that lie between longitudes 147° and 148° W. They worked offshore, through ice so scattering that it did not interfere with their progress. The weather was clear and visibility good when a hitherto unknown land appeared on their horizon. The *Takpuk* approached it through deep water, and when her bows rested against the beach the depth from her stern was 20 fathoms (Fig. 1).

THE ISLAND AND ITS DISCOVERERS

Most or all of the party went ashore and walked about on the island. It turned out to be something like half a mile long and of nearly the same width, but with irregular outline. The main axis ran northwest and southeast, and the island was highest at the southeastern end, sloping towards the northwest. The hill (at the southeastern end of the island) was about as high as the highest land on the shore line near Barrow, which is Cape Smythe, about forty or fifty feet above sea level. The surface was rolling, and there were small ponds. The vegetation was both grass and moss, and there were boulders, some of them of "considerable size," perhaps larger than a man's head. No signs of animals were noticed, and they saw no land birds. The account does not so state, but there must have been sea birds—gulls and terns—for they would be normal in September at this distance from the mainland. No driftwood was found.

The accompanying photographs were taken by one of the *Takpuk*

*After the manuscript had been submitted in its original form to the American Geographical Society it was considerably amplified by Mr. W. L. G. Joerg, in charge of polar research, who contributed the second half of the article, dealing mainly with Keenan Land. The author is greatly indebted to Mr. Joerg for his collaboration.

party and developed when the party ultimately returned to Beechey Point (149° W.). The two men seen in Figure 1 are on top of the highest part of the island. The schooner lies where the depth was 20 fathoms off her stern (Fig. 1). The third view (Fig. 3) shows the general topography, with the small ponds. Ice was pressing on the windward side of the island; the schooner is on the lee side.

FIG. 2—Men of the *Takpuk* on Takpuk's island.

Returning, the boat steered direct for Cross Island (147° 50′ W.) and reached it in 12 hours at approximately full speed, which might be anything from 6 to 8 statute miles per hour. Probably the distance is approximately 80 miles from Cross Island. As the general scene of operations had been about abreast of a point halfway between Cross Island and Pole Island (147° 0′ W.) (i.e. perpendicular to a line connecting these islands), the location of Takpuk's island would appear to be near 71° 20′ N. and 145° 30′ W.

Since this is an extraordinary report in view of exploration that has gone before, the case cannot be too well documented, which justifies the following comment:

The statement as above was given verbally by Charles D. Brower, who has read proof on it and made corrections. Brower has lived at Barrow since 1884, spending there an average of about six winters out of seven, the others in New York, San Francisco, and elsewhere. He is known to all explorers and to other travelers who have visited northern Alaska during the last 49 years and has with them all a reputation for careful observation and accurate statement. However, the foregoing account is merely one that he received verbally from Takpuk.

Takpuk has among all those who know him a most excellent reputation for truthfulness, and he compares favorably with a high-type European of the peasant or small seafaring class. Brower is of the opinion that, in view of both the clear weather and the ability of Takpuk and his crew to steer by compass (and to make allowance for its deviation), there is no doubt that the land observed lies approximately where above stated.

A résumé of the explorations that have been carried out in the general vicinity of Takpuk's island may now be given.

Exploration in the Region

The first notable work of exploration in this region was done by the Anglo-American Polar Expedition commanded by Ernest de Koven Leffingwell and Ejnar Mikkelsen on the sledge journey that they made with Storker Storkerson as their companion in the late winter of 1906–1907. Their map[1] shows them to have been about 50

Fig. 3—The lower end of Takpuk's island with small ponds, grass and moss, and boulders.

statute miles from the assumed position of Takpuk's island. On April 26, 1907, they camped by observation at latitude 71° 12′ N., longitude 147° 40′ W. From the narrative it appears[2] that the weather was clear, but there is no suggestion that anything resembling land was noted. April 27, soon after breaking camp, they took, according to their map, a sounding of 540 meters with no bottom. That day it was cloudy, but no fog is mentioned, and a dark object, such as Takpuk's island, can be seen quite as far away in cloudy as in clear weather under polar sea conditions. Mikkelsen does say that the sky to the eastward was "dark and heavy": that might be a reflection in the clouds of black land; but it might equally well be the reflection of open water, and the narrative states that there were innumerable cracks in the ice to the east. That night camp was at latitude 71° 13′ N. and longitude 147° 34′ W.

On April 28 the party remained in camp to get observations for determining the rate and direction of the ice drift. They did get a

[1] Ejnar Mikkelsen: Conquering the Arctic Ice, Philadelphia, [1909], p. 255; see also map facing p. 607 in the preliminary account in *Bull. Amer. Geogr. Soc.*, Vol. 39, 1907, pp. 607–620.

Leffingwell continued his work in the adjacent coastal belt of Alaska, spending a total of six years in the field until 1914. The results of his work are reported by him in "The Canning River Region, Northern Alaska," *U. S. Geol. Survey Professional Paper 109*, 1919 (reviewed in *Geogr. Rev.*, Vol. 11, 1921, pp. 468–469). The accompanying maps include one (Pl. 4), on the scale of 1 : 125,000, that is the best map of the coastal-fringe islands referred to in the present article.

[2] Mikkelsen, *op. cit.*, pp. 249–253; *Bull. Amer. Geogr. Soc., ibid.*, pp. 613 and 615.

71° 15′ latitude but failed to get a longitude because of clouds. From all appearances, and also from later observations, they were being carried by a westerly drift, therefore getting farther from the assumed position of Takpuk's island. Again a 500-meter sounding gave no

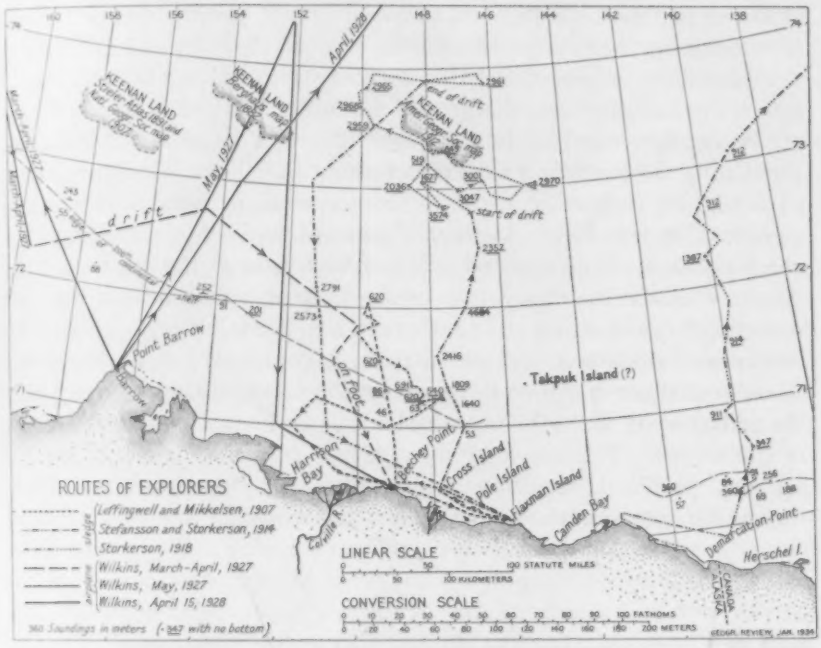

FIG. 4—Map showing the deduced position of Takpuk's island in relation to Keenan Land.

bottom. The next position, April 29, according to the text, showed 71° 05′ N., 148° 22′ W., by dead reckoning (the map would imply about longitude 148° 30′ W. in that latitude). In any case it seems from Mikkelsen's narrative and map that the nearest approach to the assumed position of Takpuk's island took place between April 26 and April 29.

The region was not further explored until 1918, when I was in command of the Canadian Arctic Expedition of 1913–1918. According to the map[3] published in connection with my narrative of that expedition, Storker Storkerson, then in charge of the sledge work, camped with his party on March 21, 1918, just barely south of 71° N. at about 147° 10′ W. They had sounded 29 fathoms and a brown mud bottom. Their next observation was not until March 28, when they were near 71° 35′ N., 147° 50′ W. However, they had taken a sounding of 897 fathoms and no bottom about ten miles north and a little west of their first-mentioned camp. No sign of land was reported in this

[3] "Discoveries in the Arctic Sea, 1913–1918," mean scale 1 : 3,000,000, in pocket of "The Friendly Arctic," New York and London, 1921.

period, during which Storkerson's route lay 40–45 statute miles from the assumed position of Takpuk's island.

Storkerson's soundings of 29 and 897 fathoms within about 10 miles of each other, taken in conjunction with his deeper soundings farther north, apparently define the edge of the continental shelf in this longitude. Mikkelsen and Leffingwell likewise found rapidly increasing depths within a short distance: in 71° 12′ N. and 148° 15′ W. the soundings increased from 66 meters to no bottom at 620 meters (36 to 339 fathoms) in a distance of 2¼ miles.[4] The trend of the edge of the continental shelf in this segment seems to be west-northwest, paralleling the coast at a distance of about 60 miles. The same trend, with slightly increasing distance from the coast, holds westward to a point abreast of Point Barrow. Eastward, for lack of soundings, the exact position of the shelf edge is not known until the waters off the Alaska-Canada boundary are reached; here, as indicated by the soundings[5] taken along the 140th meridian on the sledge journey by Storkerson, Anderson, and me in 1914, it apparently again lies about 60 miles offshore and then increases its shoreward distance to embrace the embayment of the Mackenzie delta in a wide-sweeping arc convex to the north.[6] The assumed position of Takpuk's island, 71° 20′ N. and 145° 30′ W., is about 85 statute miles from the nearest mainland. A plausible interpretation of such an island would be as a protuberance rising from the continental shelf or from its edge. The greater than average distance of Takpuk's island from the mainland is not incompatible with this interpretation, as the margin of the shelf in this area may well be sinuous or even broken into separate outliers.

The scarcely credible statement that the *Takpuk* had 20 fathoms off her stern when her bow was resting against the beach is made still more difficult by the photograph that shows the schooner at the sloping rather than the abrupt end of the island. It is, therefore, perhaps worth while to cite the only things known to me (aside from Takpuk's veracity and Brower's probably accurate reporting) that tend to make the great depth not wholly unbelievable.

When I first visited Shingle Point, lying on the coast between Herschel Island and the Mackenzie Delta (longitude 137° 20′ W.), the sand spit, then between one and two miles long, had at its tip an entrance that I remember as having a depth of about nine feet. At various times during the following twelve years this entrance was either filled up or deepened by the currents. It is said that for one brief period ships of considerable size (say 10 to 15-foot draft) could have entered.

[4] Mikkelsen, *op. cit.*, p. 245 (the map, however, indicates these depths as 63 and 620 meters and the position as centering on 71° 12′ N. and 148° 25′ W.); *Bull. Amer. Geogr. Soc.*, Vol. 39, 1907, p. 613.

[5] Map cited in footnote 3.

[6] Fridtjof Nansen: Bathymetric Map of the Arctic Basin, 1 : 20,000,000, *in* Problems of Polar Research, *Amer. Geogr. Soc. Special Publ. No. 7*, 1928, facing p. 14.

The short sand spit that makes up the protection of the whalemen's harbor at Langton Bay (longitude 125° 5′ W.) sloped almost imperceptibly to its eastern end and had such a precipitous deepening immediately beyond that, according to whalemen's report, a ship drawing 15 or 16 feet could round the tip at a distance of only a few yards. Regrettably, I never took a sounding during the seasons spent there, which is the less defensible since my curiosity was aroused by seeing ice cakes that presumably drew a great deal of water drifting by the end of the spit. I remember having had the impression from the height of the drifting ice above water that these cakes were drawing 6 to 10 fathoms, and I fail to remember ever having seen a cake of any size aground in the entrance.

Since Takpuk's island has no apparent suggestion of volcanic origin, it would seem that, if the great deepening off its end is really a fact, the isle is likely to be part of a ridge perhaps nearly or quite following the edge of the continental shelf and somehow so constituted that violent currents are at times created that sweep through a narrow opening, digging a way for themselves somewhat as the currents of Langton Bay dug a channel past the tip of the whalemen's sand spit.

Incidentally, the 20-fathom depth given by Takpuk coincides with the maximum estimate that has been given by Peary and some others, including me, for the grounding of sea ice.[7]

Earth on Floating Ice?

Brower has discussed the Takpuk narrative with Leffingwell, who also knows Takpuk. He reports Leffingwell as being of the opinion that so large an amount of earth as that here described could not possibly be floating on top of moving sea ice. A ridge of earth floating on sea ice is described in my book "The Friendly Arctic":[8]

> On all our ice trips and at every distance from shore we have found ice with a certain amount of earth or gravel upon it and sometimes fragments of rock or small boulders. The day after coming upon the sandy hummock, we found, on top of some ice that was two years old or over, a gravel and boulder ridge eighteen paces long. At its highest point it was about five feet higher than the ice on which it rested and had an average width of between ten and fifteen feet. The ridge was composed of mud, gravel, slate and boulders, the largest weighing over a hundred pounds. Some lumps of soil with lichens I took to show that it had been formed by a landslide from some steep and not entirely barren land. Apart from this earth ridge, the ice was a perfectly ordinary old floe. It was now lying thirty or forty miles from the nearest land and the depth of water underneath it was probably over thirty fathoms, although we were unable to sound right at that point; no sounding we got in the vicinity showed less than twenty-six fathoms.
>
> . . . it seemed obvious that this earth ridge had been formed by a landslide descending on ice lying near a precipitous coast.

[7] V. Stefansson: The Northward Course of Empire, New York, 1922, p. 191. This citation covers a personal statement made by Peary to Stefansson.

[8] Pp. 514–515.

I do not remember seeing in polar literature a report of any larger quantity of earth floating around on sea ice, yet the earth-on-ice theory did come to mind when Brower reported a depth of 20 fathoms from the stern of a schooner whose nose was on the beach, for that sudden deepening offshore is rare if not unknown in northern Alaska, where it is an ordinary whaler rule of thumb that a 10-fathom sounding puts you about ten miles off shore. With 20 fathoms against the beach, Takpuk's island would resemble Herald Island, at least in the precipitous way in which it rises from considerable depths. Captain C. L. Hooper, commanding the U. S. Revenue Cutter *Corwin* in 1881 when a landing was made on Herald Island (on July 29), reports that on the east and north of the island, which is six miles long by two miles wide and culminates in an elevation of 1200 feet, "we found 10 fathoms of water within half a cable length [360 feet] of shore and 20 fathoms but a short distance outside of that."[9]

The evidence so far presented as bearing on the existence of an island in the assumed position, while not positive, is yet not negative in character; i.e. the members of the two sledge expeditions that came nearest to the assumed position of Takpuk's island, as well as the participants in Wilkins' two flights northeast from Barrow (see below, p. 114), were too far away to have been able to see it (the limit of visibility of the 40-to-50 foot high southeastern end of the island would, for a person on foot, be about 15 statute miles even from the top of a high—60 foot—hummock in the pack ice, and, for an airplane at the elevations flown by Wilkins, namely 500 to 3000 feet, this limit would be about 72 statute miles), and an area a mile and a half or so in circumference seems too large to be interpreted as floating ice covered by soil.

Keenan Land

Confirmatory evidence, however, is afforded by the circumstance that land has once before been sighted in the general neighborhood. The account had best be given in the form of the original statement[10] by Captain E. P. Herendeen, a whaling captain of Wood's Hole, Mass., who plied Arctic waters from 1850 to about 1890:

> The only report of land having been seen by civilized man in this vicinity [north and east of Point Barrow] was made by Captain John Keenan, of Troy, New York, in the seventies. He was at that time in command of the whaling bark *Stamboul*.[11]

[9] C. L. Hooper: Report of the Cruise of the U. S. Revenue Steamer Thomas Corwin in the Arctic Ocean, 1881, *48th Congr., 1st Sess., Senate Ex. Doc. No. 204*, Washington, 1884, p. 52.

[10] Marcus Baker, E. P. Herendeen, A. W. Greely: An Undiscovered Island Off the Northern Coast of Alaska, *Natl. Geogr. Mag.*, Vol. 5, 1893, pp. 76–83; reference on p. 80.

[11] As a result of a search kindly undertaken in connection with the present article by Mr. W. H. Tripp, curator of the Old Dartmouth Historical Society and Whaling Museum of New Bedford, Mass., it has been determined by means of the "Whalemen's Shipping List" that Captain Keenan's command of the *Stamboul* falls in the years 1881–1882 and 1883, whereas an Arctic whaling voyage he undertook in 1877–1878 was carried out on the bark *Dawn*. The latter voyage is hence more likely to be the one on which he discovered land, in view of the further testimony secured a few months ago

of New Bedford. Captain Keenan said that after taking several whales the weather became thick, and he stood to the north under easy sail, and was busily engaged in trying out and stowing down the oil taken. When the fog cleared off, land was distinctly seen to the north by him and all the men of his crew; but, as he was not on a voyage of discovery and there were no whales in sight, he was obliged to give the order to keep away to the south in search of them. The success of his voyage depended on keeping among whales.

This fact was often discussed among the whalemen on the return of the fleet to San Francisco in the fall. The position of Captain Keenan's ship at the time land was seen has passed from my mind, except that it was between Harrison and Camden bays.

A letter addressed to Captain Keenan by the writer in February [1893], asking for more definite information as to date and position of his ship and other points of interest, failed to reach him and was returned.

By "the position of Captain Keenan's ship at the time land was seen . . . was between Harrison and Camden Bays" Captain Herendeen doubtless means that the ship had stood north from a point between these bays. This fits in well with the point of departure and course of Takpuk's power sloop, as the bays lie respectively in longitudes 151° and 145° W.

The land seen by Captain Keenan was apparently first represented on a map of the Arctic[12] published in 1882 on behalf of the International Polar Commission of that period. It is there shown, nameless, in approximately 73½° N. and 153½° W., or about 150 miles north-northeast of Point Barrow. Its next appearance, as far as known, is on the Arctic map in the 1891 edition of Stieler's atlas,[13] which is derived from the same source of information, inasmuch as it was issued by the same publisher. Here it is shown in the same latitude but farther west, i.e. in 157½° W., so that it comes to lie north-northwest of Point Barrow. This position and the same conjectural outline of its coast are copied on the standard Arctic map published by the National Geographic Society in 1907.[14] The last map in this enumera-

by Mr. Tripp from William I. Shockley, a whaling captain who knew Captain Keenan well and was in the Arctic at the time the *Stamboul* was there and visited him on that vessel. Captain Keenan made no mention to Captain Shockley of having discovered land. Captain Shockley also stated that in 1882 Captain Keenan was a very old man. That Captain Herendeen received no reply from him in 1893, a circumstance referred to below, may be due to his having died by that time.

[12] Hermann Berghaus, edit.: Länder um den Nordpol, 1 : 10,000,000, Justus Perthes, Gotha (this is probably the map to which Baker and Greely refer, *op. cit.*, pp. 76 and 80); there is a note on it in *Petermanns Mitt.*, Vol. 29, 1883, pp. 75–76.

[13] Adolf Stieler: Handatlas über alle Theile der Erde, Gotha, [1891], Pl. 6. On this map it is named, but the name is spelled Kennan Land, probably as a result of confusion with George Kennan with whose travels in Siberia the Germans were familiar.

[14] Map of the North Pole Regions, 1 : 13,500,000, *Natl. Geogr. Mag.*, Vol. 18, 1907, supplement to June number, with text on pp. 454–455. This map (sometimes with name, sometimes without) also accompanies "The Ziegler Polar Expedition, 1903–1905: Scientific Results," National Geographic Society, Washington, 1907; A. W. Greely: Handbook of Polar Discoveries, 4th edit., Boston, 1909, 5th edit., 1910; and R. E. Peary: The North Pole, New York, 1910. It was on the basis of the map in the ship's copy of Peary's book that the *Karluk* was thought to have drifted within 25 miles of Keenan Land; no signs of it were seen from the masthead in spite of clear weather (R. A. Bartlett and R. T. Hale: The Last Voyage of the *Karluk*, Boston, 1916, pp. 53–54). The drift track of the *Karluk* as shown on the map referred to in footnote 3 came no nearer than 50 nautical miles, however, of the position of Keenan Land as shown on the National Geographic Society map and hence fell short of the arc of visibility.

tion, and one taking an independent view of the position of Keenan Land, is the Arctic map published in 1912 jointly by the American Museum of Natural History and the American Geographical Society.[15] Keenan Land is here shown in 73½° N. and 147½° W., or farther east than on any of the earlier maps—a position that is indeed north of a point between Harrison and Camden bays. On this map Keenan Land, like Peary's conjectural Crocker Land, is shown on the edge of the then large unknown area. The mode of representation reflects a conjecture entertained at the time that these two areas might be part of a large unknown land mass the existence of which was deduced by R. A. Harris of the U. S. Coast and Geodetic Survey from Arctic tidal observations.[16] In the first two papers (1904) in which Harris expounded this theory, he conjectured, in addition to the large central land mass, the existence of a separate island 75 miles north-northeast of Camden Bay.[17] This he did when he was ignorant of Keenan Land. His attention was subsequently called to Captain Herendeen's statement of 1893, to which circumstance he alludes in a postscript to his first paper.[18] Harris predicated this island off Camden Bay to account for the alleged abrupt change in the time of the tide between Camden Bay and Demarcation Point at the end of the Alaska-Canada boundary. Later information showed this change not to exist, and Harris hence withdrew this conjectural island.[19]

Identification of Takpuk's Island with Keenan Land?

The evidence presented in this article seems to indicate that the land on which the Eskimo Takpuk set foot in September, 1931, is a real island and not floating soil-covered ice. That it is Keenan Land is more doubtful. Keenan Land, as represented on the various maps discussed above, always lies approximately in the same latitude, viz. 73½° N., whatever its longitude. This probably reflects the fact that the ship's latitude was known at the time of sighting land. This would be in consonance with the practice—known to me from personal observation—of the Alaskan whalers of determining their latitudes (by sextant) while being less concerned about their positions in longitude, for the determination of which—a more difficult operation—they were not so well equipped. Captain Shockley (see footnote 11) confirms the belief that Captain Keenan followed this practice on the *Stamboul*, and we may assume he also did so on the *Dawn*.

[15] Map of the Arctic Regions, 1 : 6,300,000, prepared and drawn by A. Briesemeister, New York, 1912; see also explanatory note, *Bull. Amer. Geogr. Soc.*, Vol. 45, 1913, pp. 610–612.

[16] R. A. Harris: (1) Some Indications of Land in the Vicinity of the North Pole, *Natl. Geogr. Mag.*, Vol. 15, 1904, pp. 255–261; (2) Evidences of Land Near the Pole, *Rept. 8th Internatl. Geogr. Congr., Held in the United States, 1904*, Washington, 1905, pp. 397–406; (3) Arctic Tides, U. S. Coast and Geodetic Survey, Washington, 1911; (4) Undiscovered Land in the Arctic Ocean, *Amer. Museum Journ.*, Vol. 13, 1913, pp. 57–61.

[17] *Op. cit.* (1), p. 259, and map on p. 256; *op. cit.* (2), p. 403, and map on p. 400.

[18] *Op. cit.* (1), pp. 260–261.

[19] *Op. cit.* (3), p. 80.

If a certain accuracy is admitted for the latitude of the positions in which Keenan Land is shown on the maps—positions that represent distances of 140 to 210 statute miles from the nearest land—then it seems improbable that Takpuk's island is Keenan Land, as the 12-hour journey of Takpuk's power sloop in returning to Cross Island will not permit, even at the maximum speed of that boat, an expansion of the covered distance to fit these latter figures.

If the new discovery is really an island, then, in recognition of the achievement of its Eskimo discoverers, it seems only meet that it should be known as Takpuk Island.[20]

Significance of the Discovery

In conclusion, a word as to the significance of the discovery. Of course, every disclosure of new land, however small, is of interest. In spite of the fact that the landward belt of the Arctic Sea has by now been crisscrossed by a close set of expedition routes and is hence pretty well known,[21] the present instance and the discovery by the Russian expedition on the *Sedov* in 1930 of Wiese (Vize) Island between Franz Josef Land and Northern Land indicate it to be quite possible that further islands may be discovered. This is most likely to occur on the continental shelf. The edge of this shelf, i.e. where it descends abruptly to the deep basin that the weight of evidence indicates as occupying the central portion of the Arctic Sea, represents the poleward limit of the area within which the likelihood of finding new islands is greatest, as, owing to the geological structure of the lands bordering the Arctic, it is not probable that any lands, other than isolated volcanic islands possibly, rise from this deep basin. For this reason Nansen considered[22] it a matter of primary importance to determine the edge of the continental shelf, especially north of eastern Siberia and northwest of the Canadian Arctic Archipelago, where it is least known.

Interest attaches to the discovery of the island from the standpoints of territorial sovereignty and aviation also. Although the sector principle as such[23] has not met with universal acceptance and can

[20] In the present case there is no question as to what appellative to use. In earlier cases of Arctic discoveries there is a general tendency to use "Land." The proponent of the name in the case of Captain Keenan's discovery (Marcus Baker in Baker, Herendeen, Greely, *op. cit.*, p. 78) laudably suggests Keenan Island. Those of the maps referred to above that name the island use "Land" instead of "Island." This reflects a common practice in the pre-final stage of polar exploration, when there is insufficient knowledge as to a newly discovered land to designate it by its correct appellative. When that knowledge is sufficiently advanced to reveal the true nature of a given area, modern geographical usage also reflected in the rulings of boards on geographical names, calls for its designation as an island, if that is the case, as Baffin Island, Ellesmere Island (but Grant Land, Peary Land).

[21] See map showing the unexplored areas in the Arctic Basin in "Problems of Polar Research," *Amer. Geogr. Soc. Special Publ. No. 7*, 1928, p. 14.

[22] Fridtjof Nansen: The Oceanographic Problems of the Still Unknown Arctic Regions, *in* Problems of Polar Research, *Amer. Geogr. Soc. Special Publ. No. 7*, 1928, pp. 3–14, with map referred to in footnote 19; reference on p. 7.

[23] Gustav Smedal: Acquisition of Sovereignty over Polar Areas, *Skrifter om Svalbard og Ishavet No. 36*, Oslo, 1931, pp. 54–76.

hardly be considered as a principle of international law, the present disposition of sovereignty in the Arctic[24] in effect follows that principle. Accordingly, the newly discovered island falls within the jurisdiction of the United States inasmuch as it lies between the meridians of 168° 49′ 30″ and 141° separating Alaska from Russian and Canadian territory respectively. As to aviation, the new island lies too near the coast to be in the strategic situation of an intermediate landing station on the potential world flying route between Alaska and western Europe that, with others, I have discussed elsewhere[25] and along which Sir Hubert Wilkins so brilliantly flew to Spitsbergen on April 15–16, 1928.[26] It may, however, prove of value in local flying. Such a flight as that of Wilkins northeast of Point Barrow in May, 1927,[27] would have more than reached the island if undertaken from Cross Island. With this example of the feasibility of such a flight and with the added incentive of a known objective, it is to be hoped that an airplane will in the near future fly to the vicinity of where the island has been reported and determine its position or its nonexistence.

[24] W. L. G. Joerg: Brief History of Polar Exploration Since the Introduction of Flying, *Amer. Geogr. Soc. Special Publ. No. 11*, 2nd edit., 1930, map on p. 63.

[25] The Northward Course of Empire, Ch. 7 and map. See also "The Adventure of Wrangel Island," New York, 1925, especially Ch. 1 and map at end of volume.

[26] Neither on this flight nor on the short one of May, 1927, mentioned below could Wilkins have seen the island, as his routes lay too far away to bring the island within his horizon at the elevations at which he was flying.

[27] *Geogr. Rev.*, Vol. 18, 1928, map on p. 536.

DISCOVERY OF A NEW SKETCH OF CAPE HUDSON IN THE ANTARCTIC

William Herbert Hobbs

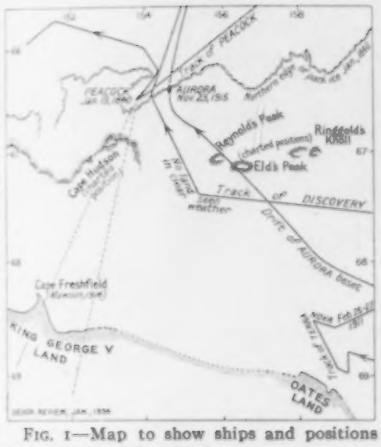

FIG. 1—Map to show ships and positions in the vicinity of Cape Hudson.

On January 19, 1840, Lieutenant, afterwards Admiral, Charles Wilkes, of the ships *Vincennes* and *Peacock* of the United States Exploring Expedition in Antarctic Seas, believed he saw land, which he named Cape Hudson, some thirty-five miles to the southwest of his position. What had looked like isolated islands had been seen and charted from the *Porpoise* of the same squadron three days earlier from a position about one hundred miles farther to the east.

These discoveries were challenged by Captain Sir James Clark Ross and other British explorers, and Captain Robert F. Scott was able in 1904, by sailing nearer under more favorable ice conditions, to show that no land exists in any of these charted positions, although the other landfalls of Wilkes throughout a stretch of nearly fifteen hundred miles have now been confirmed.

If land was seen from Wilkes's ships when Cape Hudson was placed upon the chart, it is clear that it must have been at a much greater distance than he had estimated and was at the time probably raised by mirage from below the horizon. In 1914 Sir Douglas Mawson saw and explored land in the direction in which Wilkes had seen Cape Hudson. He named it King George V Land and a headland in the position of Cape Hudson, Cape Freshfield. That there was no land between Cape Freshfield and the charted position of Cape Hudson is probable, since none was seen in clear weather from the high snow slope south of Cape Freshfield.

In a recent paper the writer, with the aid of a map based on Wilkes's original map with later additions, has reviewed the history of explorations in this region.[1]

Of outstanding importance as bearing on this question were observations made during the drift of the *Aurora*, Commander J. R. Stenhouse, of Shackleton's Antarctic Expedition of 1914–1917, for

[1] Wilkes Land Rediscovered, *Geogr. Rev.*, Vol. 22, 1932, pp. 632–655. A discussion of this paper by Professor Frank Debenham, director of the Scott Polar Research Institute, was published in the *Geographical Journal* (Vol. 81, 1933, pp. 145–148), and a rejoinder by the writer appeared in the same journal (pp. 538–540).

this ship, beset, drifted in the pack for nearly eleven months, passing over the charted positions of two of the "islands" mapped by Wilkes, and on November 23, 1915, was within fifteen miles of the position of the *Peacock* when Cape Hudson was sighted and sketched. Those aboard the *Aurora* saw land in the same general direction as that in

FIG. 2—Sketches of Cape Hudson, Antarctic. Above, from the *Peacock* (Capt. W. L. Hudson) on January 19, 1840. Below, from the *Aurora* (Commander J. R. Stenhouse) on November 23, 1915. Each sketch is on the original scale. Ship positions less than 15 miles apart. Note mirage band between loomed features and horizon in the lower sketch. The author is indebted to Commander Stenhouse for kind permission to reproduce the sketch made on the *Aurora*.

which Cape Hudson was sighted from the ships of Wilkes's squadron three-quarters of a century earlier. Says Commander Stenhouse:[2]

November 23. At 3 a. m. Young Island, Balleny Group, was seen. . . . The island, which showed up clearly on the horizon, under a heavy stratus-covered sky, appeared to be very far distant. . . . Land was seen at 8 a. m. . . . This, which would appear to be Cape Hudson, loomed up through the mists in the form of a high, bold headland, with low undulating land . . .

November 24. . . . Cloudy, clear, and fine in afternoon and evening. Not a vestige of land can be seen, so Cape Hudson is really "Cape Flyaway." This is most weird. All hands saw the headland to the south-west, and some of us sketched it. . . . We cannot have drifted far from yesterday's position. No wonder Wilkes reported land.

The writer inquired of Commander Stenhouse whether any of these sketches were still available, only to learn that during the Great

[2] Sir Ernest Shackleton: South: The Story of Shackleton's Last Expedition 1914–1917, New York, 1920, p. 332.

War a portfolio of papers had disappeared, the sketches among them. A further search instituted during 1933, while it did not disclose the missing papers, brought to light a sheet of sketches made by A. H. Ninnis of the *Aurora*. These are mainly of floe ice, and in one corner of the sheet is a sketch of the land seen at 5 a. m. on November 23, 1915. This sketch reproduced by photostat on the original scale appears in Figure 2 and is of the greatest interest and value because of its close resemblance to the sketch made on the *Peacock*.

In both sketches the main crest, the shoulder at its right, and the crests situated to the left and right are so similar and in such similar positions that the outlines might well have been drawn by two competent draftsmen working at the same time.

That land situated below the horizon is here raised into view by mirage hardly admits of doubt, and there is, furthermore, the characteristic sharply defined mirage band separating the loomed features from the horizon.[3] Such mirage bands are familiar to observers in the polar regions. It is also characteristic of such superior mirages that the features are "stretched" in the vertical direction, with this effect greatest for the higher points, so that differences of level are much exaggerated.

On Ninnis's sheet of sketches there is one of Young Island, 2000 feet in elevation and 225 miles away to the eastward, which also shows a mirage band beneath.

Though the high surface back of Cape Freshfield was about 190 miles distant from both ships, there seems no reason to doubt longer that it was in each case raised into view by mirage. Moreover, it seems possible that Cape Hudson was also seen from the *Porpoise* and the *Peacock* on January 16, 1840, but then at the greater distance of about 260 miles, when it appeared as two separate peaks, which were named Reynolds' and Eld's peaks respectively. Lines of sight extended over the charted positions of these peaks intersect those similarly drawn from the *Peacock* over the high crest of Cape Hudson and the knoll to the east at points on the snow plateau behind Cape Freshfield and behind another headland, which are indicated by Mawson in his map of King George V Land.

[3] See W. H. Hobbs: Visibility and the Discovery of Polar Lands, *Geogr. Annaler*, Vol. 15, 1933, pp. 218–224.

THE ALTITUDE AND LOCATION OF MINYA KONKA

Richard L. Burdsall

THIRTY miles south of Tatsienlu, in the Chinese-Tibetan borderland,[1] stands a group of magnificent snow mountains, whose highest peak is Minya Konka. This peak was ascended for the first time by the Sikong Expedition[2] in 1932. Previous to the ascent an altitude determination (24,900 feet) was made which we believe confirms its status as the highest measured mountain outside the central ranges of Asia and the second highest whose summit has been reached.

A résumé of our knowledge of Minya Konka (pronounced Gungka) and its surroundings was given in the *Geographical Journal* in 1930.[3] The only instrumental measurement that had been published up to that time was by the Szechenyi Expedition of 1877–1880, which gave the altitude of Minya Konka, called Bo Kunka, as 7600 meters (24,936 feet). In 1920 some members of the staff of the West China Union University in Chengtu made a survey of Minya Konka, but the results were never published. Joseph H. Rock visited the mountain in 1929[4] and gave its altitude as 25,600 feet but did not state how this result was obtained.

In 1931 an expedition from Sunyatsen University, Canton, led by Dr. Arnold Heim made a geological study of the region. An account of it is given in his interesting book "Minya Gongkar,"[5] the proof of which Dr. Heim kindly furnished to the writer. It contains many sketches and photographs and a sketch map of "Tatsienlu and the Minya Kongkar Mountains" on the scale of 1:275,000. The surveying work was under the direction of Professor Imhoff. The expedition was seriously hampered by bad weather and the detailed map has not yet been published, but Heim gives the altitude of Minya Konka based upon this survey as 7700 meters (25,262 feet) and that of Jara (pronounced with French *j*, a peak 28 miles northwest of Tatsienlu) as 5930 meters (19,455 feet).

An additional measurement of Minya Konka seemed desirable, and, as the Chinese government kindly granted permission for the work, we made it the first objective of our expedition. We also

[1] See P. H. Stevenson: Notes on the Human Geography of the Chinese-Tibetan Borderland. *Geogr. Rev.*, Vol. 22, 1932, pp. 599–616.

[2] The members of the expedition were Arthur B. Emmons III, Terris Moore, Jack T. Young, and the writer.

[3] The Mountains about Tatsienlu, *Geogr. Journ.*, Vol. 75, 1930, pp. 345–352; Herbert Stevens, Sketches of the Tatsienlu Peaks, *ibid.*, pp. 353–356.

[4] The Glories of the Minya Konka, *Natl. Geogr. Mag.*, Vol. 58, 1930, pp. 385–437.

[5] Bern-Berlin, 1933; see also *idem:* The Structure of Minya Gongkar, *Bull. Geol. Soc. of China:* Vol. 11, 1931, pp. 35–40.

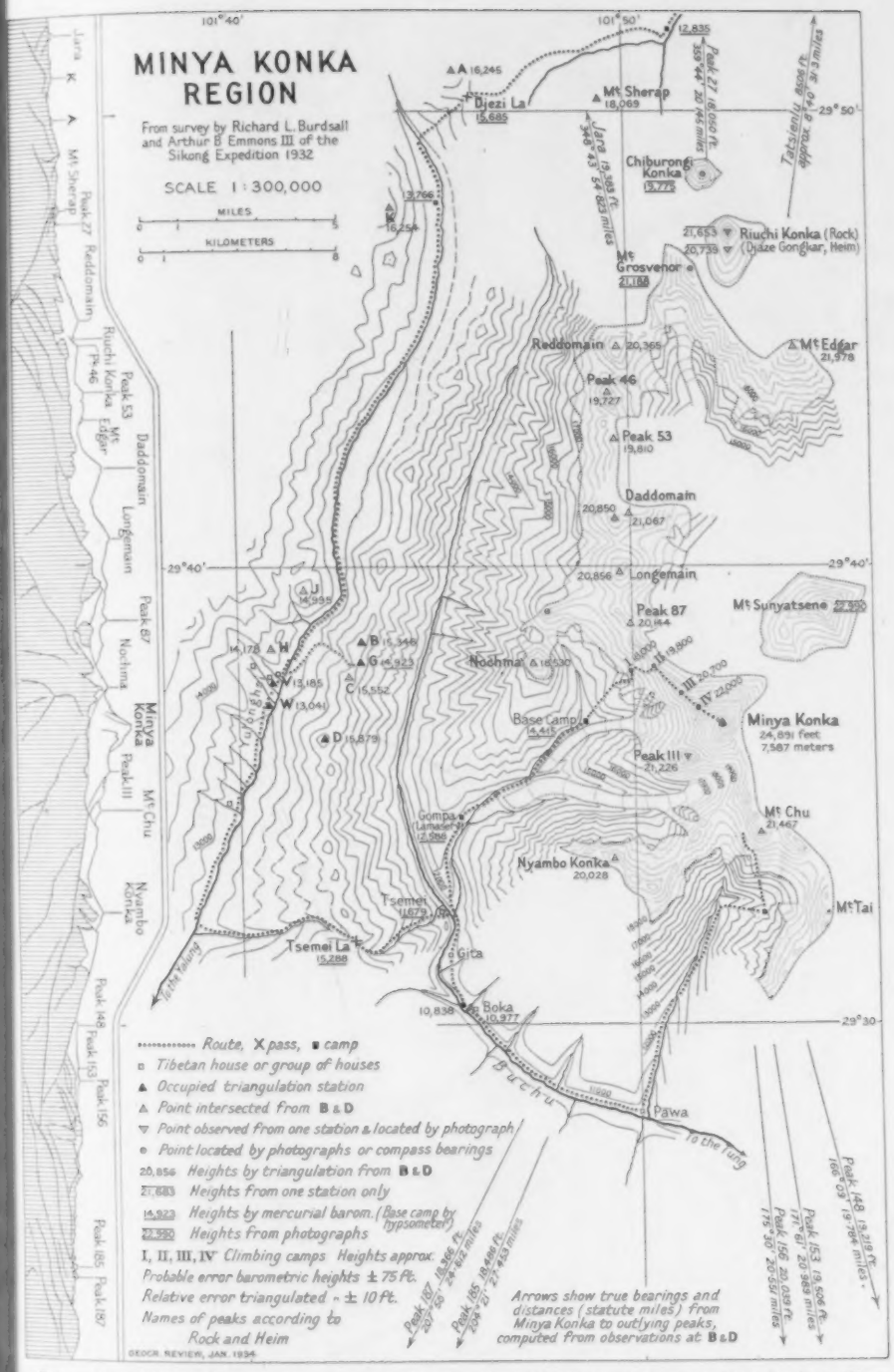
MINYA KONKA REGION
From survey by Richard L. Burdsall and Arthur B. Emmons III of the Sikong Expedition 1932
SCALE 1:300,000
MILES
KILOMETERS
101°40'
101°50'
29°50'
29°40'
29°30
Djezi La 15,685
Mt Sherap 18,069
Chiburongi Konka 19,775
Riuchi Konka (Rock) (Daze Gongkar, Heim)
Mt Grosvenor 21,152
Reddomain 20,365
Mt Edgar 21,978
Peak 46 19,727
Peak 53 19,810
Daddomain 20,850
21,067
Longemain 20,856
Peak 87 20,144
Mt Sunyatsene 22,359
Nochma 18,630
Base Camp 14,415
Minya Konka 24,891 feet 7,587 meters
Peak III 21,226
Mt Chu 21,467
Gompa Lamasery 12,586
Nyambo Konka 20,028
Mt Tai
Tsemei 16,179
Tsemei La 15,288
Gita
Boka 10,977
Pawa
Route, X pass, ■ camp
Tibetan house or group of houses
Occupied triangulation station
Point intersected from B & D
Point observed from one station & located by photograph
Point located by photographs or compass bearings
20,856 Heights by triangulation from B & D
21,683 Heights from one station only
16,923 Heights by mercurial barom. (Base camp by hypsometer)
22,950 Heights from photographs
I, II, III, IV Climbing camps Heights approx.
Probable error barometric heights ± 75 ft.
Relative error triangulated ~ ± 10 ft.
Names of peaks according to Rock and Heim
Arrows show true bearings and distances (statute miles) from Minya Konka to outlying peaks, computed from observations at B & D
GEOGR. REVIEW, JAN. 1934

FIG. 1—Map of Minya Konka. Above the snowline (heavier dotted line) contours are shown by dotted lines. The panoramic sketch is from station B: the area below the snowline is shaded.

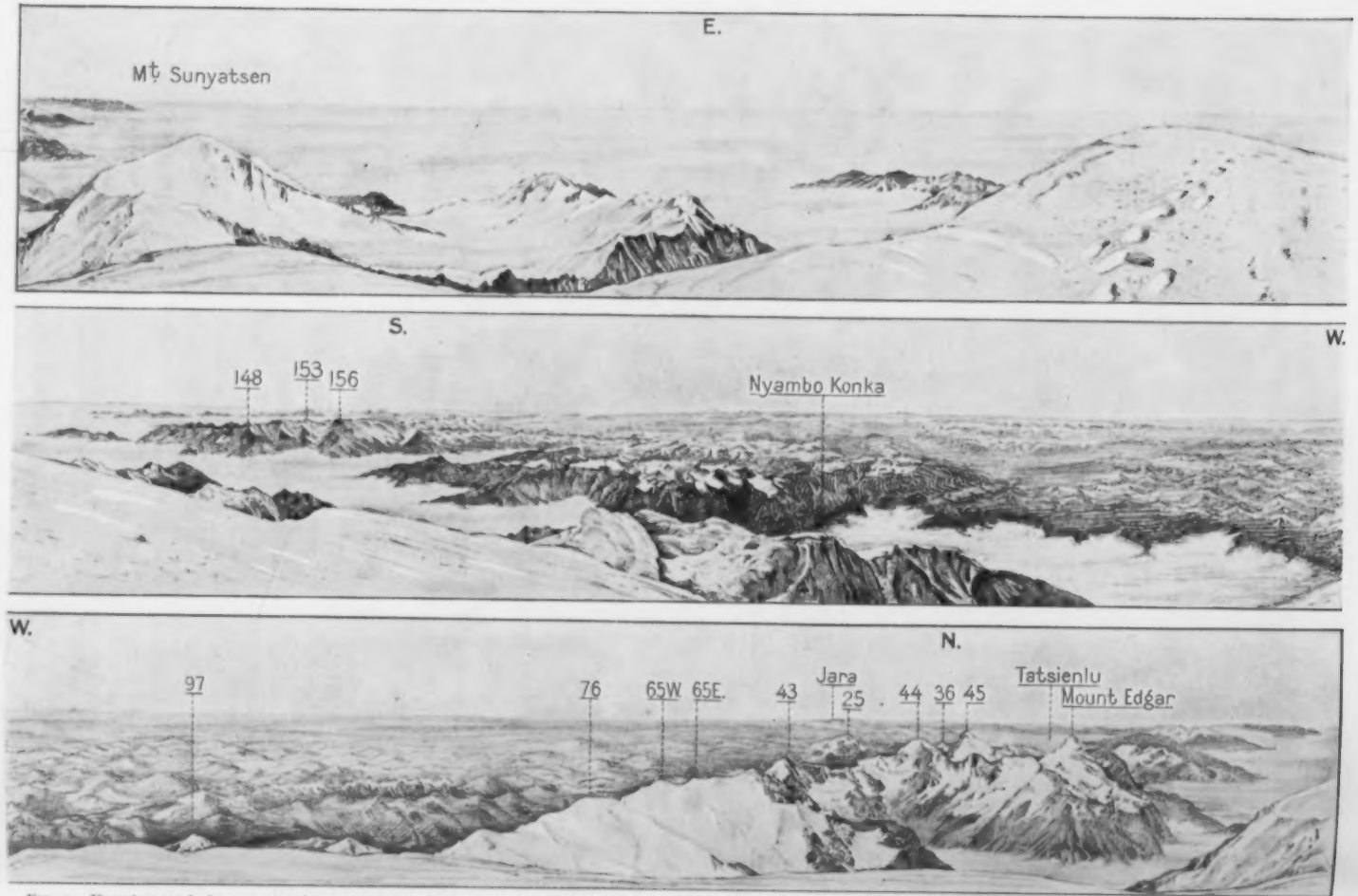

FIG. 2—Drawing made from a complete panorama of photographs taken on the summit of Minya Konka (Oct. 28, 1932). Of the numbered peaks 97 is Nochma; 65, Daddomain; 43, Reddomain; 25, Mt. Sherap; 44, Mt. Grosvenor; 36, Chiburongi Konka; 45, Riuchi Konka. Tatsienlu is below the clouds.

FIG. 2—Drawing made from a complete panorama of photographs taken on the summit of Minya Konka (Oct. 28, 1932). Of the numbered peaks 97 is Nochma; 63, Daddomain; 43, Reddomain; 25, Mt. Sherap; 44, Mt. Groavenor; 36, Chiburomgi Konka; 42, Riuchi Konka. Tatsienlu is below the clouds.

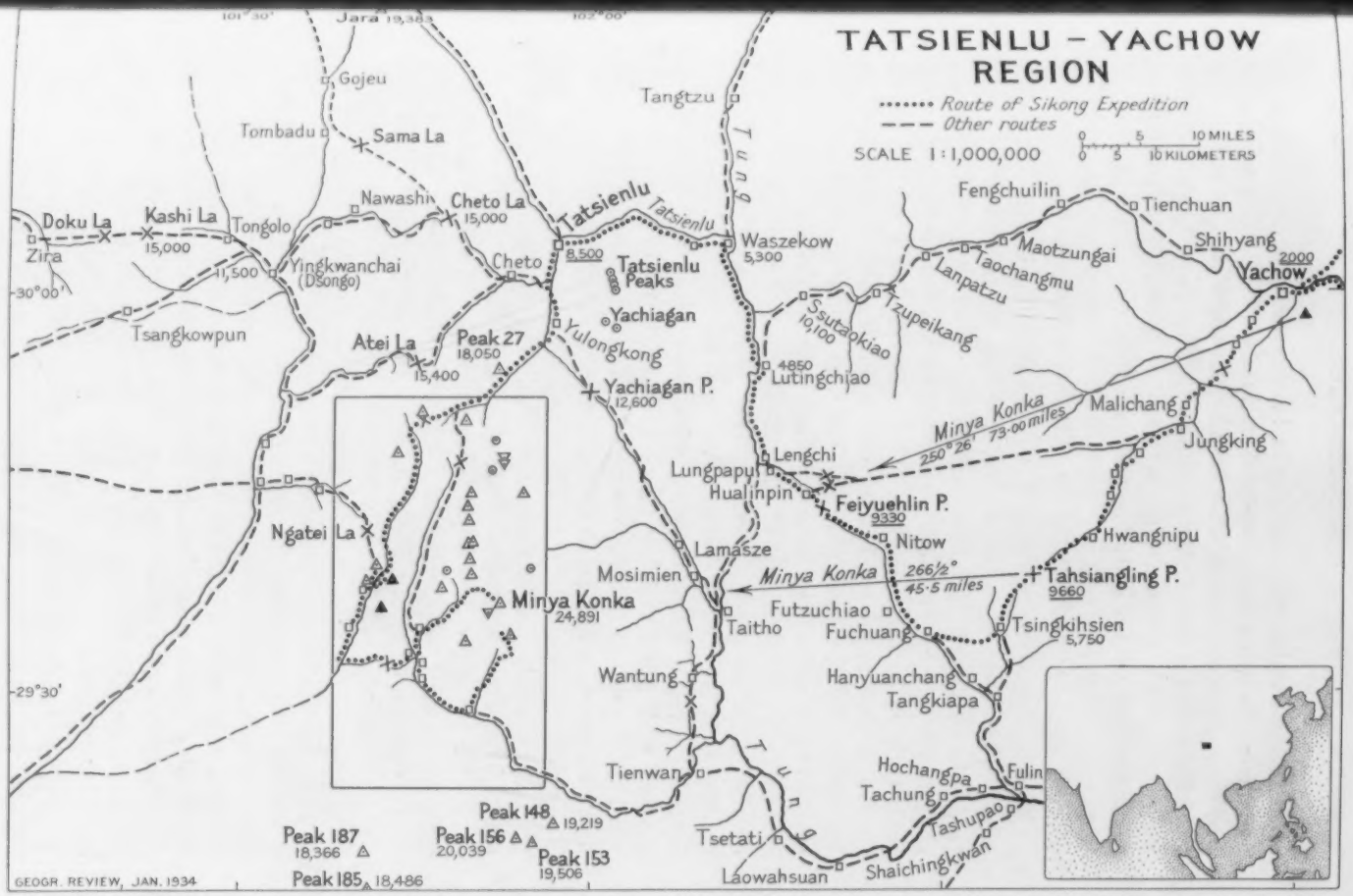

FIG. 3—This map was compiled from Survey of India 1 : 1,000,000 sheet 100 and "Kartenskizze von Tatsienlu und Minya Gongkar-Gebirge, 1 : 275,000," by Heim and Imhof, with a corrected grid and a few other changes and additions by the Sikong Expedition. Symbols are the same as on Figure 1. Peaks were given numbers corresponding to their magnetic bearings from station B. The position of Peak 156 agrees roughly with that shown for Tzumei Mt. on the Survey of India sheet.

measured a number of other peaks in the vicinity, including Jara, and determined their geographical positions. While this was all we had expected to accomplish, we found that with complete panoramas from Station B and from the summit of Minya Konka, together with numerous other photographs, we had sufficient material for the accompanying map, Figure 1.

Approach to the Mountain

Leaving Moore and Young to complete arrangements and equipment for an ascent of the mountain, Emmons and the writer, who were to do the surveying, left Shanghai on June 16, 1932.[6] Tatsienlu was reached on July 23, and four days later we started southward with a pack train of horses and yaks. Our route led up a narrow valley. On the second morning following our departure we crossed the Djezi La (15,700 feet), whose summit, like that of all Tibetan passes, is marked by a cairn of stones supporting sticks with prayer flags. Mist and hail prevented a view of the mountains, so, after Emmons had climbed a hill to erect a stone beacon (Station A on map), we descended into the Yulong Valley. We were now in the Tibetan grasslands, the valley being carpeted with short grass and the hillsides covered with grass and low bushes. The elevation (13,700 feet) is too high for crops, but in summer the Tibetans pasture their yaks here: we passed many herds containing several hundred animals. At Yulonghsi we found three widely separated stone houses; and over the crest of a ridge to the northeast, beside a tiny lake, we located our camp, from which we hoped to see Minya Konka.

As rainy weather was expected soon, we lost no time and by the next afternoon had selected two stations on the ridge (B and D). That evening we had our first glimpse of the mountain and found that the stations were satisfactorily located. When we looked out of our tent the next morning, it was clear, and we beheld a sight unsurpassable in its rugged grandeur. Across the deep Buchu Valley stood the range of snow-clad mountains, while beyond a second little valley rose Minya Konka, towering far above its enormous neighbors.

It is interesting to note in passing that all the drainage from this mass of mountains passes into the Tung River, while the ridge on which we stood, though a mile lower in altitude, forms the divide between the Tung and the Yalung.

Determinations of Altitude

Stations B and D, on which 7-foot stone beacons had been erected, were about 2.6 miles apart. As the terrain was such that this dis-

[6] For details of the journey and for an account of the ascent see Arthur B. Emmons, III: The Conquest of Minya Konka, *China Journ.*, Vol. 19, 1933, pp. 14–21; and Terris Moore: The Minya Konka Climb, *Amer. Alpine Journ.*, Vol. 2, 1933, pp. 1–17.

tance could not be measured directly, a base line V-W was selected in the Yulong Valley. The mountains cannot be seen from this valley, and a traveler from Tatsienlu, crossing the Djezi La in bad weather, as we did, might continue down the valley on his way south without a hint of their existence.

Having laid out the base line, we postponed its measurement and again turned our attention to the high stations B and D, the latter nearly 100 feet higher than Mt. Blanc. Fortunately we were able to get our sights before the bad weather began. Horizontal and vertical angles were measured to 25 peaks, including Jara 50 miles away to the north. We used a Keuffel and Esser transit reading to minutes. All readings were taken face right and face left, bubble corrections being applied to the vertical angles. Sixteen altitudes were taken of Minya Konka and six of Jara, and the horizontal angles to these peaks were measured by repetition. Our sights were completed on August 9. The mountains were never clear for long after that: from August 18 to September 17 we had some rain or snow every day but three. Conditions then began to improve, and while we were on the mountain in October the weather was fairly good.

The base line of 3185.15 feet was measured twice with a steel tape, the discrepancy being 0.56 feet.[7] It was then extended to B-D, all the angles being measured by repetition at each corner of the quadrilateral. A small triangulation was required to connect our camp (Station G), where the barometer readings were taken, with Station B. The altitude of Minya Konka above our camp was found to be 9963 feet, the calculations through B and D showing a discrepancy of 11.5 feet. Judging from the angles involved and from photographs taken on the summit, 5 feet seems the right amount to add to this figure for the height of the true crest above the point of tangency of our sights. The value .60 was used as the index of refraction.

A series of 70 barometric readings was taken at camp from July 31 to August 25. We used a Fortin-type barometer loaned by the American Geographical Society—the first mercurial barometer to reach Tatsienlu without breaking. Its index error and that of the attached thermometer were determined by the Zikawei Observatory in Shanghai before our departure. The observatory publishes a daily weather map for China showing isobars at 6 a. m. Upon my return to Shanghai I was kindly supplied with these for each day of our observations. Their nearest station was at Chungking[8] about 275 miles east of our

[7] Correction was made for temperature of the tape, which has since been checked by the U. S. Bureau of Standards.

[8] Leveling has been carried up the Yangtze only as far as Hankow, but from a long series of barometric observations the zero mark on the river gauge at Chungking is considered to be 546.5 feet above sea level. The mercurial barometer of the Customs Office, which reports to Zikawei, is 165.9 feet above this, or 712.4 feet above mean sea level.

camp, so the isobars for our location can be only approximate. However, they seem to offer the best values obtainable, and I used them to get the sea-level pressure, interpolating for the time of our observation and making a correction for diurnal variation. For the mean temperature of the hypothetical air column I used the temperature at time of observation for the upper station and assumed a gradient of 0.30° F. per 100 feet to get the sea-level and mean temperatures.[9] The temperatures were taken with a small sling psychrometer, which has since been checked by the U. S. Bureau of Standards.

The altitude was worked out independently from each of the 70 observations according to the Smithsonian Meteorological Tables. The unsatisfactory status of the temperature correction is shown by the fact that, while the uncorrected altitudes show a range of 351 feet, the altitudes corrected for temperature and average degree of humidity show a range of 744 feet. Observations taken at midday, when the temperature was high, gave higher altitudes than those taken in the morning or evening. The temperature correction, however, must be made, and there does not appear to be any better method of making it. Though the range in altitude is considerable, there were few observations near its limits, and the mean of the 70 observations gives a value whose probable error is considered to be ±0.5 per cent or ±75 feet. This figure, 14,923 feet, was accepted as the altitude of our camp (Station G), and all the altitudes obtained by triangulation were based upon it. This, added to the height of Minya Konka above our camp, gives 24,891 feet (7587 meters) as its altitude above sea level. We believe the probable error of this result is about ±85 feet, and as a round figure call the altitude 24,900 feet or 7590 meters.

On November 28 I measured the altitude of Minya Konka from the side of Tsokungshan overlooking Yachow. The result was 24,629 feet or 262 feet lower than the figure given above. Another peak, Mt. Edgar, came out 177 feet lower than the altitude obtained for it at our survey camp. These results are based on our figure of 2000 feet as the elevation of Yachow. Because of the distance (73 miles) and the uncertainty in the elevation of the instrument the only value attached to these observations is that of a rough check.

It may here be worth while to comment on the Szechenyi Expedition's figures for Minya Konka and Jara, as the figure for the former is nearly correct and for the latter (7800 meters or 25,592 feet) very much in error. The account of the determination, which was made by Lieutenant Kreitner, is contained in "Die Wissenschaftlichen Ergebnisse der Reise des Grafen Béla Széchenyi in Ostasien 1877–1880"

[9] The suitability of this figure was confirmed by correspondence with the U. S. Bureau of Standards and the Weather Bureau, and sea-level temperatures computed by it are fairly consistent with records at Chungking. A change of 0.014 in the value of this gradient will give a change of 1° F. in the mean temperature of the air column and a change of 30 feet in the resulting altitude.

(Vienna, 1893–1899). Describing his method Kreitner says:[10]

> . . . I determined the position of conspicuous peaks and summits of mountains and other prominent objects by compass bearings, and, as far as practicable, from several, or one other, similar bearings, plotted the angles graphically. I thus obtained a distance, within the possible limits of accuracy, for the fixed object from my position, in order to ascertain the relative difference of height by measuring the vertical angle. On a rapid journey on public roads, it is possible only occasionally to set up the theodolite, so a few only of the determined heights were measured with that instrument. I generally used for sighting the corners of my rectangular survey-box, on the reverse side of which I had constructed a quadrant with a 5° scale, or else the compass of the expedition's geologist, fitted with a contrivance for reading vertical angles.

In his table of altitudes Kreitner does not state whether the theodolite or the rougher instruments were used. Bo Kunka (Minya Konka) was measured from Dsongo, which is the Tibetan name for Yingkwanchai. Its elevation is given as 3482 meters, the distance to the mountain 16,000 meters, the vertical angle 14° 30′, and the resulting altitude 7655 meters, which is rounded off to 7600 meters. According to Heim's map the true distance is 55,500 meters. Kreitner's angle would therefore indicate an altitude of 18,100 meters! Using our altitude for Minya Konka and Heim's altitude (3500 meters) and distance for Yingkwanchai, the vertical angle there should be 4° instead of 14° 30′. As Kreitner's figures are consistent, there does not appear to be a typographical error, and the position on his map is in agreement with them. Misidentification suggests itself, but his sketch from Dsongo (p. 703) is obviously the same as Stevens' sketch from the same place. Stevens gives another sketch of Minya Konka in nearly the same aspect from Haja La. Here he had his back toward Kreitner's position of the mountain, which, according to Edgar, is occupied by "rolling downs with excellent pastures."[11] Kreitner's measurement of Jara was made from Kashi La. Its elevation is given as 4474 meters, the distance to the mountain 33,000 meters, vertical angle 5° 35′, and resulting altitude 7774 meters, which is rounded off to 7800 meters. According to Heim, the true distance is 47,600 meters, and Kreitner's angle would indicate an altitude of 9400 meters. Using our altitude for Jara and Heim's altitude (4600 meters) and distance for the Kashi La, the vertical angle there should be 1° 23′.

Determination of Position

While in camp we were unable to ascertain our position, because our wireless set had not arrived, the sun at noon was too high for observation with our transit, and at night we were always enveloped in cloud. We did, however, take time and azimuth observations from

[10] From translation in the *Geographical Journal* (Vol. 75, 1930, pp. 347–348).

[11] J. H. Edgar: Notes on the Mountains about Tatsienlu, *Geogr. Journ.*, Vol. 82, 1933, pp. 264–267.

the sun, using an assumed position. As the position is now known, these sights have been reworked, and the four azimuth observations show a range of only 4′ 34″. A single compass bearing taken with the transit showed a magnetic variation of 0° 36′ W. Thirty-three bearings taken with a pocket compass at B showed variations of 38′ E. to 1° 57′ W., the mean of all being 53′ W.

On our return journey we obtained the position of Yachow, using the John Ball adaptation of the Marc St. Hilaire method—observing six stars and taking six altitudes of each. We consider that the location obtained is correct within one-quarter of a mile. Moore obtained time signals on a wave length of 33.8 meters from Station NPO, Cavite, P. I. A good watch was used, and the rate was determined by a series of receptions before and after the observation.

From the side of Tsokungshan the angle was measured between Minya Konka, Mt. Edgar, and a line to a point in Yachow. Later the direction of this line was obtained by two sun azimuths, which agreed within one minute. The distance from the station on Tsokungshan to the point in Yachow was 12,300 feet measured roughly by stadia. Our work at camp gave the distance from Minya Konka to Mt. Edgar and the direction of the line joining them. This, with the angle at Tsokungshan and the directions from there, allowing for convergence of meridians, gave sufficient data to solve the triangle. We consider the resulting location of Minya Konka to be correct within one mile (see Table III).

TABLE I—BAROMETRIC HEIGHTS RECORDED JULY TO DECEMBER, 1932

STATION	DATE AND TIME	NO. OBSERVATIONS	FEET ABOVE STA.	AIR TEMP. °F. MEAN	AIR TEMP. °F. RANGE	PRESSURE (REDUCED TO STD.) MEAN	PRESSURE (REDUCED TO STD.) RANGE	PRESSURE AT SEA LEVEL[2] MEAN	PRESSURE AT SEA LEVEL[2] RANGE	ALTITUDE OF STATION[3] FEET MEAN	ALTITUDE OF STATION[3] FEET RANGE	ALTITUDE METERS
Chengtu . .	July 12 22:40	1	17	87	....	27.901	....	29.602	....	1756	....	535
Yachow . . .	July 15 18:30	1	15	85	....	27.699	....	29.687	....	2044	....	623
Yachow[1] . .	Nov. 28 11:45	2	8	54	2	28.177	.079	30.243	.108	1957	30	596
	Dec. 1 11:15											
Tahsiangling .	July 18 15:30 15:40	2	2	74	2	21.334	.002	29.520	.004	9665	46	2946
Feiyuehlin . .	July 20 16:05 16:35	2	2	60	0	21.386	.006	29.540	.003	9332	4	2844
Tatsienlu . .	July 24 to July 27	11	15	69.6	16	22.139	.198	29.602	.186	8533	545	2601
Tatsienlu[1] . .	July 25 to Sept. 6	28	3	62.2	21	22.205	.315	29.786	.509	8480	363	2585
N.E. Djezi La	July 29 18:35	1	2	46	....	18.758	....	29.494	....	12,835	....	3912
Djezi La . .	July 29 10:45–13:40	4	2	47.7	7	17.111	.022	29.532	.032	15,685	232	4781
Upper Yulong	July 29 18:20	1	2	47	....	18.184	....	29.481	....	13,766	....	4196
Station G . .	July 31 to Aug. 25	70	3	43.8	28	17.571	.150	29.705	.449	14,923	744	4549
Tsemei La . .	Aug. 26 9:30 9:45	2	2	41.7	1.5	17.420	.016	29.880	.000	15,288	23	4660
Tsemei . . .	Aug. 26 13:05	1	50	55.5	....	19.865	....	29.829	....	11,679	....	3560
Konka Gompa	Aug. 26 18:20	2	2	49	8	19.174	.012	29.807	.076	12,588	304	3837
	Aug. 27 11:00											
Boka House .	Aug. 27 18:45	1	15	53	....	20.281	....	29.773	....	10,977	....	3346
Boka Camp .	Aug. 28 to Sept. 19	5	2	53.2	15	20.451	.064	29.861	.128	10,838	179	3303
Base Camp[1] .	Oct. 5 19:00	1	0	31	....	17.745	....	29.957	....	14,415	....	4394
Camp I[1] . . .	Oct. 7 19:00	1	0	28	....	15.615	....	30.008	....	18,078	....	5510

[1] By hypsometer; other readings by mercurial barometer. The hypsometer was compared with the barometer by 10 simultaneous observations at Station G and 2 at Tatsienlu. The hypsometer read low, the mean of the differences being .028″. All hypsometer readings in the table have been corrected by adding this amount. The station at Tatsienlu was the China Inland Mission building. The series of hypsometer observations was made by the Rev. R. L. Cunningham using our spare thermometer in his hypsometer. This was checked by comparison with our hypsometer and gave the same reading.

[2] From weather maps of the Zikawei Observatory corrected for time of observation and diurnal variation.

[3] By Smithsonian Meteorological Tables using temperature gradient of 0.30° F. per 100 feet.

TABLE II—TEMPERATURES RECORDED (1932)*

PLACE	ALTITUDE	DATE	TIME	TEMPERATURE °F.
Station G	14,923	Aug. 23	Minimum	29.5
Base Camp	14,415	Oct. 6	"	31
" "	"	Oct. 14	"	20.5
" "	"	Oct. 15	"	21
Camp I	18,000	Oct. 8	8:00 a.m.	15
"	"	Oct. 16	Minimum	14
Camp III	20,700	Oct. 25	9:00 a.m.	5

*These were the only temperatures recorded in addition to those of the barometric observations. Using a gradient of 0.30° F. per 100 feet, the corresponding temperatures at the summit of Minya Konka would range from 0° to −11° F.

TABLE III—POSITIONS DETERMINED

PLACE	LATITUDE (N.)	LONGITUDE (E.)
1. Yachow	29° 59′ 38″	102° 58′ 55″
2. Minya Konka	29° 36′ 32″	101° 52′ 12″
3. Station B	29° 38′ 20″	101° 43′ 05″
4. Station G	29° 37′ 53″	101° 43′ 05″
5. Jara	30° 23′ 22″	101° 41′ 26″
6. Tatsienlu (Approx.)	30° 03′ 30″	101° 58′ 50″
7. Tahsiangling Pass (Approx.)	29° 38′ 44″	102° 37′ 40″

The first position (tennis court of Dr. R. L. Crook, American Baptist Mission, Yachow) was obtained from six stars and is considered correct within one quarter mile. The next four were derived from it by azimuths and triangulation and are probably correct within one mile. The last two may be two miles in error; that of Tatsienlu is based on topography shown on photograph from summit of Minya Konka and upon our route to the mountain; that of Tahsiangling Pass is based on pocket compass bearings to Minya Konka and neighboring peaks and photographs of them taken from the pass.

THE NAME MINYA KONKA

Regarding the name Minya Konka, Rock says:[12]

In June of 1928, while exploring the Konkaling snow peaks to the northwest of Muli, I beheld from a ridge, at 16,300 feet elevation, a series of snowy ranges, one of special interest far to the northeast. My Tibetan guides said this was Minya Konka. . .

Stevens makes this observation:[13]

. . . when between Yatsu and Baurong before the descent to the gorge of the Yalung, I had an impressive view to the east of snow mountains, which the lama and carriers spoke of as the Minya Gonka. . .

However, in the *Geographical Journal* for September, 1933, Edgar says:

"Bang Gangs t'Kar" (pronounced "Bo Gang Kar") is now as it was in Kreitner's day the local designation. When at the Gang Kar Monastery in 1931 its scholarly abbot gave me, in the Tibetan script, the words "Bang Gangs t'Kar," asserting that they represented the official name. The same applies to the head monastery about 35 miles in a southerly direction on the Yalung side of the mountains.

When we visited the monastery the head lama was away on a visit to Lhasa. However, Edgar gave me the script referred to, transliterated and translated as follows: a'Bang Yul Gangs dkar, revered region ice white. The word "Gangs" is the same as the first syllable in Kanchenjunga, the great mountain north of Darjeeling, India. In his book Heim gives a cut showing the name as written for him by the head of this same monastery: this may be transliterated as:

[12] *Op. cit.*, p. 385.
[13] *Op. cit.*, p. 355.

Men-as Kun-gar. The lama evidently spelled incorrectly, as the dictionaries of Jaeschke and Sarat Chandra Das both give Mi-nyag as the name of the province.

The natives called the mountain simply Konka (pronounced somewhere between Gongka and Gungka). In considering the two names Bo Konka and Minya Konka, it seems to the writer that there are likely to be other "revered" konkas in Tibet; if so, the first name would not be distinctive. There is only one Minyag, and, while there are other lesser konkas in it, this is the outstanding one, and therefore Minya Konka seems to be a suitable name. We could not substantiate from natives the names that Rock used for the other peaks as we were somewhat handicapped by lack of a good Tibetan interpreter. On the accompanying map the names are as used by Rock and by Heim, with the German spelling anglicized.

The results of our work are given by the accompanying tables and by the map. In closing, I wish to express our appreciation to the missionaries in China who helped us in many ways, to Father Gherzi of the Zikawei Observatory, and to O. M. Miller and John Kay of the American Geographical Society for assistance given both before our departure and since our return.

A NATIONAL PLAN FOR AMERICAN FORESTRY*

Henry S. Graves
Yale University

THIS document, commonly called the Copeland Report, is a compendium of the existing knowledge regarding the forest problems of the country, an analysis of the economic factors bearing on these problems, and an interpretation of their significance in the life of the nation. With this economic background there is presented a national plan of forestry to be developed progressively through the coördinated efforts of the federal government, the states, lesser public agencies, and private interests. The publication of this survey of forestry problems and plan of action represents the culmination of many years of effort by foresters and other interested persons to develop a comprehensive forestry policy for the nation.

The conception of national planning in forestry had its real beginning in the conservation movement initiated by President Theodore Roosevelt in 1908. Immediately after the World War a new impetus was given to the movement for a recognized program of forestry for the nation. Under the leadership of the Forest Service, the Society of American Foresters, and other interested agencies notable achievements were accomplished in the form of federal and state legislation, which strengthened the system of national forests, advanced state forestry, established on a large scale systematic fire protection and other coöperative undertakings, and provided for a broad program of research in all phases of forestry—accomplishments that have, however, been largely confined to the public agencies.

Balancing the Timber Budget

Since the settlement of the country great inroads have been made in the forests, partly by clearing for the beneficial use of the land for agricultural, industrial, and home-site purposes, and partly by unregulated exploitation, fire, and other destructive processes. We learn from the Copeland Report that forest lands now embrace in the aggregate about one-third of the land area of the country. Of this about five-sixths, or nearly 500 million acres, is capable of producing timber of commercial size. The balance is scrub forest or open woodland, whose chief value is in its use to protect watersheds, to conserve scenic features, to harbor useful wild life, and for recreation. As far as area of forest land is concerned, we should have enough to meet the needs of the country for raw materials and other services if it were in good productive condition. Vast areas of forest have been depleted of their marketable timber, and the tracts of mature forest have been dwindling and, with the progress of exploitation, are found ever farther from the centers of population, where the products are most needed. Furthermore, in cutting timber practically no attention has been given to insuring new growth of value. Nature, even in the face of great abuse, tends to reclothe land with trees in the humid regions. The first stands, however, are inferior and of little prospective value as regards species, form, and quality of trees, rate of growth and yield, and density of stocking. The natural restoration of forests of real value is a long process extending over several tree generations.

Many forests covering a very large area, especially in the east, comprise depleted remnants, low-grade second growth, and some completely devastated sections. The statistics in the Copeland Report indicate that slightly less than 20 per cent of the forests may be classed as old growth; 18 per cent, second growth large enough to

*Report of the Forest Service of the Agricultural Department on the Forest Problem of the United States, *73d Congr., 1st Sess., Senate Doc. No. 12*, 2 vols., Washington, 1933.

produce saw timber; 24 per cent, second growth of cordwood size; 20 per cent, having a fair stand of young trees; and 17 per cent, with very poor reproduction or none at all.

Such statistics as the foregoing do not, however, give a picture of the forests as they exist. The first consideration is the distribution of merchantable timber. It is disconcerting to find that about 90 per cent of the standing saw timber of the country is in the far west and south and that even in the vast southern forests the merchantable timber is now only 12 per cent of the total in the country. Thus is emphasized the depleted condition of the forests of the east, especially of the northern tier of states.

A second important problem relates to the distribution of size classes of trees in the forests of a given region or locality. Where the forests are in good condition for continuous industrial service there is not only timber large enough for present use but also material of intermediate size and age, which will in the near future grow into the merchantable class. In many of our forests not only the older but also the intermediate trees have been cut or destroyed. Even if the land is well stocked with thrifty young-tree growth a long period must elapse before there is raw material to support industrial establishments and provide employment.

The annual drain on our timber resources continues large in spite of a progressively declining per capita consumption. During the five-year period prior to 1929 this drain, for cut and used material alone, amounted to more than 14,495 million cubic feet annually, of which about seventy-five per cent fell in the category of lumber and allied products from trees of saw-timber size. In addition there were annual losses of 870 million cubic feet from fire and 985 million cubic feet from insects, disease, wind, etc. The total drain of 16 billion cubic feet is about twice the estimated current annual growth. The growth of saw timber is only about one-fifth the amount cut or destroyed each year!

These are eloquent facts, and they suggest an inquiry as to how the present growth of timber compares with that that might take place under an orderly system of forest management. The Copeland Report indicates that by entirely feasible methods—results of long study tried out in practice—it would be possible to double the growth and to secure a sustained annual yield equal to the estimated normal drain on the forests for commodity uses. The growth and yield could be still further increased 20 per cent or more by the application of specially intensive methods of silviculture, if the effort was justified by future needs. It is assumed in these calculations that the forests are managed on a basis of sustained yield, with all that this means in forest protection, the conservation of immature timber, provision for forest reproduction, careful logging, and building up of forests already depleted. This would be accomplished through the program presented in the report.

Uneconomic Exploitation and Its Results

The changes in economic conditions during the last decade have brought into vivid relief the consequences of uncontrolled exploitation of timber, depletion of local supplies of raw material, and forest devastation. Exhaustion of timber has resulted in the depopulation and impoverishment of many sections of the country. Farm abandonment has followed the closing of lumber establishments, and tax delinquency of both farm and depleted forest lands has increased to great proportions. Through mismanagement and abuse of forests and forest grazing ranges erosion has increased and local torrents have become more frequent and destructive and river flows more irregular. It is the private owner who is mainly responsible. As expressed by the Secretary of Agriculture in his letter transmitting to Congress the report of the Forest Service:

"The overload of forest land and timber in private ownership and the cut-out-

and-get-out policy have led to excessively large capital investments in manufacturing plants, high capital charges, pressure to liquidate, overproduction, demoralized prices, waste of the raw product, and large financial losses to the forest industries and chiefly to the lumber industry.

"Transient forest industries resulting from the conditions described have caused far-reaching and utterly demoralizing economic and social losses to dependent industries, to local communities, and to entire forest regions. The full extent and far-reaching character of such losses has been but little appreciated."

Need of Public Participation

The conclusion in the Copeland Report that private owners have failed as custodians of the forest resources is unescapable. So also is the conclusion that there is a definite limit to the extent to which private ownership may be relied on in the conservation and stable management of forests. It is clear that there are very large public interests inherent in forests and that it is unreasonable to expect private owners to expend effort and money on measures calculated to provide public benefits that do not at the same time react to their own benefit. Herein is to be found the basis for the new program of the Forest Service, which calls for a very much larger undertaking by the government, states, and lesser public agencies than has been conceived before. It is not proposed that the public should take over the entire task of forestry: in fact, about half would still be left to private enterprise; and, taken by itself, this is a responsibility of great magnitude.

The principle that the forest problem of our nation requires the participation of the public is not new in this country, and it has been recognized in other countries for many years. Public activity is shown first in the actual ownership of forests. Forestry on a substantial scale began in this country with the establishment of the system of national forests, the greater number of which were created early in the present century. The first national forests were areas already owned by the nation as parts of the public domain, and there was required only Congressional authority for forest reservations and provision for their protection and administration. In 1911 the Weeks Law was enacted, which authorized the acquisition by purchase of forest lands that would be serviceable in protecting the watersheds of navigable streams. Later this authority was broadened to include lands needed for timber production; and legislation was also passed to permit the addition of lands to the national forests by exchange, with certain restrictions, and by gift. The national forests now embrace more than 160 million acres.

New York was a pioneer in the policy of state forests, establishing the Adirondack Forest Preserve in 1885. The policy of state forests was not generally extended to other states until comparatively recently. At present 30 states possess organized state forests, which aggregate in area 4,395,549 acres. There are 801 town and municipal forests in 20 states and 59 county forests in 7 states. Parallel with the public forests are systems of national, state, county, and municipal parks. Many of these parks contain forest land, in some cases carrying a large amount of timber of merchantable character. Economic use of the timber on the parks is, of course, prohibited. These forests, however, render many of the same public benefits as do the public forest reservations; for example, the prevention of erosion and watershed protection.

Proposed Additions to Public Forests

At the present time about one-fifth of the commercial forest land of the country is in public ownership. A considerable part is in the mountains, comprising the less accessible and formerly less attractive forests from the viewpoint of commercial exploitation, and most of the areas acquired in recent years had been cut over at

least once prior to transfer to public ownership. Nevertheless, the public forests contain more than 500 billion board feet of merchantable timber and in some regions are an important factor in providing raw material for industry. They are under systematic protection and management.

The most important feature of the program of the Forest Service in the Copeland Report is the proposal to increase the area of publicly owned forest land by the acquisition of about 223 million acres. This would bring the area of public forests to about three-fifths of the total forest area of the country. Many factors must be considered in estimating what proportion of the acquisition should be assumed by the federal government. Among these is the present and probable future ability of the states to assume the financial obligations involved in taking over private land and giving the new state forests an efficient administration. The conclusion reached by the Forest Service is that the federal government would have to assume the task of acquiring about 60 per cent of the new acreage and that the states and lesser governmental agencies would be responsible for the balance.

This program of public acquisition is not based on a mere guess but on a mass of information obtained from local sources. Wherever there is reasonable prospect that lands may, in the long run, be handled constructively in private ownership, they are eliminated from consideration for public acquisition. Forest lands of special value for general public benefits and requiring a type of management that private owners are not likely to provide are marked for public acquisition, assuming always that units of appropriate size may be established. Where extensive areas have been devastated, it is assumed that the public must take a large part in their restoration and should acquire strategically located areas as centers for this work.

The proposed distribution of the lands to be acquired by the public would be approximately as follows: 3 per cent in New England, 3 per cent in the middle Atlantic states, 12 per cent in the lake states, 17 per cent in the central states, 44 per cent in the south, 13 per cent on the Pacific coast, and 8 per cent in the Rocky Mountains.

The cost of the acquisition program would approximate 750 million dollars, two-thirds of which would fall on the federal government. The acreage cost to the states would be proportionately less than to the government, partly because a great deal of land would revert to the former for tax delinquency and partly because the program proposes that the government include in its purchases certain lands in the far west that carry a substantial volume of timber of merchantable size.

The program of public activities goes much further than acquisition of land. It involves a large expansion of yearly expenditures for the administration and improvement of public forests and parks; for coöperative work in the protection of private forests from fire, insects, and disease; for forest extension and education; for production and distribution of planting stock; for advancement of recreation and wild-life management; and for research, experimentation, and demonstration.

Aids to the Management of Private Forests

Practically all the proposed public activities in the national plan of forestry aid in the management of private forests. Public forests serve as demonstrations of forest practice and as effective centers of coöperation in fire protection, in coördination of groups of owners in handling specified economic units on a sustained-yield basis, and in encouraging the establishment of permanent industries that will provide a market for material from private as well as public forests. The program of coöperative aid in forest protection, in providing cheap planting stock, in extension work, in research, and in the reform of the state system of taxation of forest lands is designed to help the private owner in his task of rational forest management. One of the most important contributions in the Copeland Report relates to the practical

measures of management applicable to private forests. Research and experiments have demonstrated that the cutting of the smaller trees not only is unprofitable but often costs more than can be realized from this class of material. These are precisely the trees that should be left standing as a basis for growth and for later utilization. Other measures of practice are described, which are entirely feasible for private owners.

The report points out that there are already in existence in most states regulations in regard to the protection of forests from fire, and there are federal and state laws to prevent the spread of insect and fungus pests. With minor exceptions, there are, however, no laws regulating cutting or insuring regrowth of forest stands analogous to those in effect in most European countries. The report contains a full discussion of public regulation of private forest management, indicating its possibilities and the difficulties under American conditions. The Forest Service does not, however, propose definite legislation for regulation as a part of its general program. It concludes that "from the public standpoint, regulation with the exceptions indicated [i.e. as a condition for public loans, authorization for mergers, curtailment of production, etc.] could be held in reserve for possible future use in case public acquisition lagged so seriously behind the program recommended as to jeopardize the public interest, or in case of the continued failure of private owners to keep or to bring their lands into productivity."

Value of the Copeland Report

The Copeland Report is the most valuable contribution that has been made to the literature of American forestry. It is packed with facts and interpretative explanations of the prevailing problems of forestry that will aid every one interested in bettering the condition and service of our forests. Differences of opinion will arise in regard to some of the policies and specified features of the proposed program of action. There are few who will challenge the broad conclusions underlying the program. In fact most of these principles have already been recognized. The first question that may be raised relates to the extent of the program for public acquisition of forest land.

In the opinion of the reviewer the amount of land proposed for acquisition represents what the public should own if the best national service of the forests is to be attained. He has, however, reservations in regard to certain features of the acquisition program—the extent of government purchases in some regions, the proposed federal acquisition of some 90 billion feet of merchantable timber in the west, and the period of time proposed to complete the program. These, however, are matters that will largely find adjustment in the process of carrying out the plan. Sheer economic conditions will determine whether the public can afford to supply the resources essential to carry out the recommendations of the Forest Service.

High commendation is due to the Forest Service and especially to Mr. E. H. Clapp, chief of the Branch of Research, and to his many associates, who were responsible for assembling the information in the Copeland Report and preparing a program that challenges the interest of every serious student of our forest problem.

AMERICAN GEOGRAPHICAL SOCIETY

The November Meeting. The regular monthly meeting of the American Geographical Society was held on November 21, 1933, at the Engineering Societies' Building, 29 West 39th Street, President Finley in the chair. The address was delivered by Air Commodore P. F. M. Fellowes, leader of the Houston-Mt. Everest Expedition, which in April, 1933, made two flights over Mt. Everest. Although disclaiming any real "conquest" of the great peak, the expedition overcame tremendous difficulties in flying from a height of 120 feet above sea level to altitudes of 35,000 feet and over, from a temperature of 110° F. above zero to one of 40° below, and in the operation of the vertical, oblique, and moving-picture cameras. The overlapping strips of the vertical photographs are to be used by the Geographical Section of the British General Staff in an attempt to construct a map of this region whose isolation and extreme relief have hitherto defied efforts of topographers. Commodore Fellowes discussed the objectives of, and preparations for, the expedition and showed motion pictures taken on the flights and a series of colored slides, some of which were made from photographs taken by the use of infra-red rays.

At the meeting there were presented with the approval of the Council the names of 190 candidates who were duly elected as Fellows of the Society.

The Louise A. Boyd Expedition to East Greenland, 1933. This expedition, which was sponsored by the American Geographical Society and organized and led by Miss Louise A. Boyd, has been successfully concluded. The steamship *Veslekari*, a well known Norwegian sealing vessel, was chartered, and the expedition left Aalesund, Norway, at the end of June, returning there about the middle of September. A few days were spent at Jan Mayen Island on the way over, and the coast of Greenland was reached on July 13, very little drift ice being encountered on the way. One of the main objectives of the expedition was to explore an unknown area lying to the west of the heads of Franz Josef Fiord and Ice Fiord, and most of the time available was spent in this region, where geological studies were made and detailed photogrammetrical surveys of some of the glacial-marginal features were executed. Physiographical studies were conducted over a larger area, and in connection with them a modern type of self-recording echo sounder was employed very successfully in determining cross sections of the bottoms of many of the numerous fiords in the region.

The scientific staff of the expedition consisted of Miss Louise A. Boyd, leader and official photographer; Professor J Harlen Bretz of the University of Chicago, physiographer; Mr. Noel E. Odell, geologist; Mr. O. M. Miller of the staff of the American Geographical Society, surveyor; and Mr. Walter A. Wood, Jr., assistant surveyor.

Recent Publications

A New Volume on the Discovery of the Amazon. There has just been published by the Society a new volume entitled "The Discovery of the Amazon" (*Amer. Geogr. Soc. Special Publ. No. 17*). The bulk of the 500-page volume is a translation from the Spanish of a work of the same title by the eminent Chilean scholar, the late José Toribio Medina (see *Geogr. Rev.*, Vol. 21, 1931, p. 333), which has not easily been accessible to students as it was issued (in Seville, 1894) in an edition of only two hundred copies. The most important part of Señor Medina's book is the original account of Orellana's voyage of discovery down the Amazon in 1541–42 by one of the members of the expedition, Friar Gaspar de Carvajal, of the Order of Mercedarians. On the basis of this account and a number of other contemporary documents included in the volume, most of which had never before been published, Señor Medina prepared this authoritative and critical discussion of one of the major and

picturesque exploits of the Spanish conquest. Father Carvajal's narrative enables us to relive day by day the constant struggle to procure food, the encounters with the Indians (including the first contact with the women warriors from whom the river got its name), and the many hardships endured by the expeditionists until their emergence into the Atlantic and their safe arrival at the island of Cubagua off the coast of present-day Venezuela.

Señor Medina's volume deals also with the expedition to the cinnamon country conducted by Gonzalo Pizarro, the brother of the conqueror of Peru, from Quito into the eastern foothills of the Andes in search of the same valuable food-preserving spice which had acted as so potent a lure in the other half of the world. Indeed, it was as a foraging reconnaissance from that expedition that Orellana's voyage down the Amazon was begun. Señor Medina's volume closes with an account of Orellana's second expedition to the Amazon (1545–46), on which, approaching its mouth from the east, he intended to establish settlements in the fertile country of the lower valley but lost his life in the attempt.

The translation of the volume was, with Señor Medina's permission, originally undertaken by Mr. Bertram T. Lee, an American engineer long resident in Peru and a student of the early Spanish history of that country and collector of original documents bearing on that history which now form the Harkness collection of the Library of Congress. Professor H. C. Heaton of the Department of Romance Languages of New York University later collaborated in the translation and undertook the editing of the whole work. To Medina's volume he added a translation, the first in English as far as known, of a second, independent version of Friar Carvajal's account that had been incorporated in his "Historia General y Natural de las Indias" by the contemporary historian Fernández de Oviedo and published by the Royal Academy of History in Madrid in 1855. Professor Heaton, in his critical introduction to this document, is of the opinion that the version published by Medina was written by Carvajal immediately on completion of the voyage to be given to Orellana to take to Spain to serve as a basis for his petition for a grant of territory and that the version published by Oviedo was written later, with greater leisure and a calmer perspective, as the record to hand down to posterity in Oviedo's quasi-official history. At all events, the inclusion of both versions in the Society's volume, together with the various corollary documents, provides the reader with an exhaustive treatment of the story of the first voyage on the world's mightiest river.

Distribution of Title Page, Contents, and Index of Volume 23 of the Geographical Review. The title page, table of contents, and index for Volume 23 of the *Geographical Review* (1933), which is issued separately, will shortly be ready for distribution. Copies are sent to all institutions exchanging publications with the Society and to individuals who request that their names be put on a list for this purpose.

GEOGRAPHICAL RECORD

NORTH AMERICA

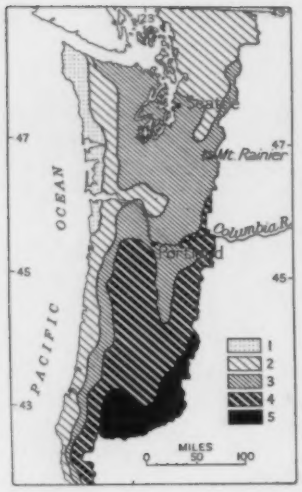

FIG. 1—Climatic fire hazard in the Douglas fir forest of western Oregon and Washington, derived from a combination of precipitation, drought, relative humidity. In zone 1 conditions are least severe; increases in successive zones are: 2, 50 per cent; 3, 100 per cent; 4, 150 per cent; 5, 200 per cent.

Climatic Conditions in Relation to Forest-Fire Hazard. An average annual burn of 41½ million acres on forest land of the United States (1926-1930) means that "fire must be considered as a widespread national problem," says the report on "A National Plan for American Forestry" discussed elsewhere in this *Review*. The loss sustained from forest fires is vividly described for an individual case in an article in the November, 1933, number of *American Forests* (L. F. Cronemiller: Oregon's Forest Fire Tragedy). The Tillamook conflagration of August last was "the most destructive forest fire Oregon has experienced in sixty-five years. Originating on privately-owned timberlands and sweeping through the finest virgin forest in Oregon, it consumed in eleven days more than 10,000,000,000 board feet of timber, chiefly Douglas fir, valued at $200,000,000. It burned over more than 300,000 acres." It started at a time of very low humidity, when the fire hazard from logging was great.

An analysis of weather conditions as a contributive fire hazard in western Oregon and Washington has recently been made by Mr. H. B. Shepard, of the Pacific Northwest Forest Experiment Station, a résumé of which appears in the February, 1933, number of the *Bulletin of the American Meteorological Society* under the title "Rating Summer Climate for Forest Fire Insurance Purposes." The elements considered in Mr. Shepard's study are amount of precipitation, length of drought periods, number of days of low relative humidity, and degree of low relative humidity. These were mapped separately and zones of relative risk defined, and the four elements were finally combined in a single map. The results are shown on a reduced scale in the accompanying figure.

Mr. Shepard also calls attention to the work of the National Board of Fire Underwriters "for the purpose of determining the variable influence of climate on fire hazard rating for ordinary property." The National Board has published (1931) two maps of the United States showing respectively the relative hazard due to high winds, snowfall, and hurricanes, and severe cold weather, hot dry weather, and tornadoes.

Regional Planning for New York; Population Statistics of New York and Boston. Reference has been made in these pages to the first volume of the Regional Plan of New York and its Environs, which appeared in 1929 and dealt with "present and suggested land utilization and means of communication" (*Geogr. Rev.*, Vol. 20, 1930, pp. 323–326). The second (final) volume (The Building of the City, 1931) constitutes a report on principles for guiding the building, or vertical growth, of the city and of the towns and villages within the region.

The Regional Plan of New York was intended to serve as a guide for the growth of the region during the next forty years. Since 1928, in spite of the depression, good progress has been made toward its realization. Indeed, the Regional Plan

Association expresses the opinion that "progress to date is such that, if it continues at the same rate, the whole of the proposals of the plan for physical improvements will have been carried out before the forty years have elapsed." The developments of 1929–1932 inclusive are summarized in "From Plan to Reality: A Report of Four Years' Progress on the Regional Development of New York and Its Environs, with a Program of Present Needs and Opportunities" (Regional Plan Association, Inc., New York, 1933).

In the volume just cited city and regional planning are described as having "to do with the lives of the people who make their homes in and about our cities, especially as they are affected by the physical features of the communities in which they live." Indispensable, therefore, to both regional planning and research in city geography is an analysis of the distribution, character, composition, and changes in population. Statistical materials for such an analysis covering New York are elaborately presented in "Population of the City of New York, 1890–1930," compiled and edited by Dr. Walter Laidlaw and published in 1932 by the Cities Census Committee, Inc. The statistics there set forth are based primarily on the United States census tabulations but go into much greater detail than the published census reports. Many of the tables classify the population by "census tracts"—territorial units of about 40 acres each. For statistical purposes the advantages of small, permanent units of area in cities, where ward and precinct boundaries are frequently changed, were emphasized by Dr. Laidlaw as long ago as 1906. Most of the present census tracts were marked out before 1910, and comparable figures for them have been published for 1910, 1920, and 1930. Recently the census-tract idea has spread to other cities, where it has been adopted—notably in Cleveland, Chicago, and Boston—for the recording of statistics of population, disease, crime, relief, etc. Although its special province is New York, one of the express purposes of the Cities Census Committee is to "suggest, and on occasion to assist, like work in other cities."

Less elaborate than Dr. Laidlaw's compilation, but of interest because it points out possible applications of the census-tract method to definite problems, is a report by the Bureau of Research and Studies of the Boston Council of Social Agencies bearing the title "Social Statistics by Census Tracts in Boston: A Method of Neighborhood Study" (1933). The maps accompanying this study show by census tracts land use, density of population, foreign-born heads of families, median rentals, and public relief (see also R. M. Cushman: Social Service in Boston, *in* New England's Prospect: 1933, *Amer. Geogr. Soc. Special Publ. No. 16*, 1933, pp. 431–445, especially pp. 439–441).

During recent decades the density of population has shown a tendency to decrease in the inner parts of many of the great cities of the world. In New York "the most extreme congestion of the city was a concomitant of the huge Southeastern European immigration of the years 1905–1910, and was reached in 1910." At that time "the Lower East Side,—New York South of 14th Street and East of 4th Avenue, the Bowery and Catherine Slip,—" had a density of 543 persons per acre. There were three census tracts of over 800 persons per acre, or about half a million to the square mile. Between 1910 and 1930 improved transit and economic conditions enormously reduced this congestion, and the parts of the city that were the most crowded in 1910 have lost nearly half of their population. A similar movement has affected the North, West, and South ends of Boston.

It should be noted, however, that decreasing population in the hearts of large cities does not necessarily mean less crowding in tenements. Business blocks or buildings may replace apartment houses, but in the dwellings that remain overpopulation and congested conditions may persist. This would appear to be the case in a part of the North End of Boston. Although the North End as a whole lost population between 1920 and 1930, one of the census tracts there gained 147.8 per cent during the decade, and the inhabited portion of this tract, with a density

of 1420 persons to the acre in 1930, was apparently more crowded than any neighborhood in New York.

Geological Guidebooks to the United States. Thirty guidebooks in pamphlet form were published last summer under the auspices of the U. S. Geological Survey for the benefit of the geologists who took part in the excursions held in connection with the Sixteenth International Geological Congress. With three exceptions, each guide covers a particular region. In most cases a general account of the geology precedes a detailed itinerary. Geographers will turn with particular interest to the clear block diagrams and maps, the brief discussions of geomorphic features, and the data on mineral resources. Special attention is directed to the following: No. 7, on the geomorphology of the central Appalachians, written in part by Douglas Johnson; No. 9, on New York City and vicinity, containing articles by A. K. Lobeck, C. P. Berkey, and others on local physiography, glacial geology, and the geological problems encountered in the construction of the George Washington Bridge, the tunnels under the Hudson, and the Catskill Aqueduct; Nos. 16 and 17, which include contributions by W. M. Davis on the geomorphology of the San Francisco Bay and the Salt Lake regions and by F. E. Matthes on the Sierra Nevada; No. 22, by J Harlen Bretz, on the channeled scabland of the Northwest; and No. 26, on the glacial geology of the central states.

Some Land Forms of California. Professor W. M. Davis's residence of recent years in the western United States has been productive of a large number of papers on land forms of that part of the country. One of the most recent of these, "The Lakes of California" (*Cal. Journ. of Mines and Geol.*, Vol. 29, 1933, pp. 175–236), may well serve not only as a local guide but as a short treatise on lake origin and evolution, so varied and comprehensive in type are the lakes described: the accompanying map identifies 129. They include lakes (past and present) as features of tectonic origin—in fault-block basins of various ages, sag ponds, and in association with landslides; forms of glacial origin such as cirques and over-deepened troughs, as in the ice-scoured Sierras; lakes in limestone-solution basins; lakes of volcanic origin in association with lava-dams, craters and hot-springs; river-made lakes—associated with ox-bows, flood-plains, and marshes, delta-barred basins; plunge-pool lakes; artificial reservoirs; lake-like lagoons. Clear Lake in the northern Coast Ranges offers some features of special interest. Before the landslide occurred that created Clear Lake only a few centuries ago, the earlier accident of a lava flow diverted the drainage system with curious consequences to the fish fauna of the region. Beautiful Lake Tahoe has "a section for itself." It is of complex origin: held by a volcanic barrier in the southern part of a down-faulted trough.

Professor Davis adds that "the knowledge of California lakes is as yet by no means complete. It is therefore hoped that what is here told about those which have already been examined may lead to new investigations. . . . In case new studies of our lakes should include good photographs, preferably from an elevated point of view so as to show the whole breadth of the water surface in its setting with its near as well as its far shore, the State Division of Mines would be glad to add prints of such views to its growing collection of landscape portraiture."

In "Granitic Domes of the Mohave Desert, California" (*Trans. San Diego Soc. of Nat. Hist.*, Vol. 7, 1933, pp. 211–257) Professor Davis describes forms to which A. C. Lawson gave the name panfans. They result from the degradation of granitic masses "chiefly by one or the other of two somewhat unlike erosional processes. . . . One process involves mainly the back-wearing of the steep scarps of an upfaulted granitic lowland, previously degraded to low relief, the detritus shed from the retreating scarps being swept away by sheetfloods. Down-wearing of the upfaulted mass by streams is in this case relatively unimportant. The back-wearing takes

place in a manner first analysed by Lawson . . . but his analysis is here somewhat modified. . . . The second process of dome production, which involves mainly the down-wearing of broadly upwarped granitic masses of low relief by the excavation of ordinary valleys along innumerable, divaricating drainage lines, will be discussed in another essay, to be published in the Bulletin of the Geological Society of America under the title, Sheetfloods and Streamfloods."

From the desert Professor Davis turns to the coast in a closely argued paper, "Glacial Epochs of the Santa Monica Mountains, California" (*Bull. Geol. Soc. of Amer.*, Vol. 44, 1933, pp. 1041–1133). "The Santa Monica Mountains of southern California are far too low to have been glaciated, but the features of their south-facing coast are believed to record four epochs of sea rise and abrasional advance alternating with three epochs of sea lowering and withdrawal during intermittent coastal upheaval; and these seven epochs of high and low sea level are interpreted as representing the last four Nonglacial Epochs (including the present Postglacial) and the last three Glacial Epochs of the Quaternary Glacial Period."

The three papers noted above are all illustrated with admirable photographs and the inimitable sketches and diagrams that we expect from the author.

Rejuvenation by Fault Coast Formation in Northern Canada. One result of the Oxford University Hudson Straits Expedition of 1931 is a map, by Captain C. M. Singer, and a considered and well illustrated physiographic paper by Ian Cox (Rejuvenation on Akpatok Island: A Topographical Unconformity in North-Eastern Canada, *Geol. Mag.*, Vol. 70, 1933, pp. 67–83) relating to a little-known island that lies in the mouth of Ungava Bay eighty miles west of the northern extremity of Labrador. Akpatok Island is a tabular block of nearly level Ordovician limestones, with a horizontal extent of 14 by 28 miles to its cliff-bound coasts and a thoroughly mature upland surface 600 to 800 feet in height. The island is dissected by short radial streams that rise in ill defined depressions, follow wide valleys for short distances, and then, by sudden increase of gradient that commences at the 600-foot level, continue to the sea through ravines and gorges with numerous falls and hanging tributaries.

These youthful watercourses are clearly incisions in wide ancient valleys, and the principal problem is to determine the cause and age of the marked rejuvenation of the fluvial cycle. Considering stream betrunking, due to faulting rather than to intense marine retrogression, as the most probable cause of rejuvenation, Cox concludes that Akpatok Island is a stable horst dissociated from the foundered surrounding Ungava region by faulting in the late Pliocene and ravined before glaciation by local ice. In view of the physiographic effects of Pleistocene and Recent earth movements and erosion on the Labrador coast, one cannot avoid feeling that Cox has given insufficient consideration to the possibility that these agencies may have contributed largely to the present form of Akpatok Island.

M. A. PEACOCK

SOUTH AMERICA

Observations on Climate and Disease in Ecuador. Walter Knoche in "Klimatische Beobachtungen auf einer Reise in Ecuador" (separate from *Verhandl. Deutschen Wissensch. Vereins zu Santiago de Chile*, Vol. 2 (N.S.), 1932) takes as his text the importance of travelers' descriptions over and above meteorological statistics in painting the picture of the climate of a country. While he admits that travelers react unequally to cold, heat, insect bites, etc., he dismisses this objection and proceeds to his description of the "microclimatic" factors observed on his own journey in Ecuador in 1930. But it must be recalled that Dr. Knoche himself has special qualifications for making such observations.

His paper is a stimulating and interesting commentary. In a country such as

Ecuador that extends in a short horizontal distance from sea level to 21,000 feet above the sea the climatic complexities are great, and so the author has wide range for his study of botanical variation, distribution of insects, prevailing winds, rains, and temperatures, and the distribution of the inhabitants and their diseases as due to climatic influences.

The last-named subject he deals with at greater length in "Bio- und medizinisch-geographische Beobachtungen auf einer Reise durch Ecuador" (*Phoenix*, Vol. 17, 1931, pp. 135–167 and 217–247). Especially interesting are his remarks on tuberculosis. This, "the great enemy of the human race," is widespread in the hot lowlands of the coast of Ecuador. He says the deaths from tuberculosis in Guayaquil in the period 1908–1919 amounted to 6000, i.e. more than the total deaths from yellow fever, malaria, bubonic plague, and dysentery. He further states that for the years 1908–1914 there were 3200 deaths from tuberculosis out of a total mortality of 11,000 (about 30 per cent) and adds that experienced physicians estimate the tuberculosis death rate for the entire coastal region at 15 per cent. Accepting his estimate of the population of Guayaquil as 90,000 (1919), this would make the tuberculosis death rate per annum (1908 to 1919) more than 500 per 100,000 inhabitants, which is in contrast with recent reports (1929) of 76 per 100,000 for all the territory of the United States, 110 per 100,000 for the Hawaiian Islands, and 250 per 100,000 for the Philippine Islands.

In an address delivered October 18, 1932, Dr. Wade W. Oliver, formerly of the Rockefeller Institute, whose figure we quoted for the Philippines, states that one person out of every 26 in these islands has tuberculosis. Assuming an equal ratio between active cases and those resulting in death in Guayaquil, it would seem that one out of every 13 inhabitants of Guayaquil has tuberculosis—truly a frightful condition. One can believe the statement of Dr. Fr. Cebanilla, quoted by Knoche, that the small number of inhabitants of the coastal provinces of Ecuador is due to tuberculosis. Dr. Oliver thinks the serious condition in the Philippines is due to malnutrition, poor housing (including inadequate sanitation), high heat and humidity, low income of families, and infestation with animal parasites. To the reviewer, these would equally well explain the widespread occurrence of tuberculosis on the coast of Ecuador.

Knoche is also disturbed by what he calls the "tragic" death rate among children in Guayaquil. He says that out of a total mortality of 4955 (length of time not given) there were 2605 deaths of children under six years of age and that of this total 2200 were infants less than a year old. Dr. Antonio J. Bastidas, professor of medicine in the Universidad Central in Quito, on April 8, 1932, called the attention of the country to the terrible death rate among children. He says the birth rate of Ecuador is 34 per 1000 inhabitants and that in spite of this the increase in population is only 13.6 per 1000. For the year 1928 Dr. Bastidas notes a mortality of children under one year of 153.43 per 1000 births. In the United States in 1929, 50 infants died out of every 1000 born.

It may be of hope to our friends in Ecuador to learn that in the United States in 1920 there were 100 deaths per 1000 births and that this has been reduced to one-half in nine years. Dr. Bastidas lays the blame for the terrible mortality among infants to alimentary diseases, infections, and lack of care, the last—the most important—being due to ignorance, poverty, illegitimacy, alcoholism, deficient medical care, etc. Bastidas states that the percentage of illegitimate children born in Ecuador runs from 11.6 per cent (province of Chimborazo) to 83 per cent (province of Los Rios). Walter Knoche, in laying most of the blame to the adulteration of milk in Guayaquil, points the way to the reduction of this terrible suffering among mothers and children; viz. an aroused public sentiment, organization, and education. Both tuberculosis and excessive infant mortality are largely problems of organization and education.

JOSEPH H. SINCLAIR

The Sugar-Loaf Knobs of Southeastern Brazil. Various explanations have been suggested from time to time to account for the peculiar sugar-loaf knobs that form so characteristic a feature of the landscape of parts of southeastern Brazil. That they are the product of the weathering of crystalline rocks under conditions of high temperature and humidity seems well established, but the process itself has remained obscure. A detailed investigation recently published brings to light many things not previously understood concerning these land forms (F. W. Freise: Brasilianische Zuckerhutberge, *Zeitschr. für Geomorphologie*, Vol. 8, 1933, pp. 49–66).

Freise counts 52 sugar-loaf knobs in southeastern Brazil. In every case, he says, they are composed of gneiss; all of them are located in areas of crystalline mountains or crystalline plateaus. Although they are commonest near the coast, some occur far inland. Detailed study shows that they are generally elliptical in outline, in only a few cases approaching a circular ground plan; further, that the longer axis is invariably at right angles to the prevailing wind and that the more variable the local winds the nearer the outline is found to approach a circle. In profile the knobs are generally asymmetrical, with a steeper, in some cases vertical, lee side and with a gentler windward side, which is rounded and smoothed. The tops also are mostly rounded.

Weathering and denudation are very active on these exposed rock surfaces. On the Pão d'Assucar, at the entrance to Guanabara Bay (Rio de Janeiro), where the construction in 1908 of a cable line to the summit exposed fresh rock, decomposition has proceeded to a depth of 45 centimeters in the course of 22 years. These processes, however, are quite different on the windward and lee sides. Freise has found that the rainfall received on the windward side in the course of a year is only about 35 to 45 per cent of that received on the lee side. On the drier side the rate of weathering is much slower; even the nature of the weathering process is fundamentally different. Here the exposed rock is scaled off in layers or plates, mostly only a few centimeters in thickness—a scaling that is produced by the differential expansion of the surface heated to a high temperature by the intense tropical sunshine. There is little accumulation at the base of the knob on this side, and the rock surface of the knob itself is smoothed and rounded, especially near the top, where heating and exfoliation are most active. On the lee side, on the other hand, moisture penetrates deeply into the rock mass: denudation of the loosened material proceeds so vigorously that the slope is quickly steepened and worn back, and a thick accumulation of waste is formed at the base. The many individual variations of form discovered among the examples that were studied were found to be the result of local peculiarities of the rock structure.

Freise's study contributes important details regarding the outline and profile of these knobs in relation to rock type and local climatic conditions. His interpretation, however, leaves much to be desired. The initial form with which he starts his discussion of the weathering and denudation processes is that of a more or less symmetrical bare rock knob. He avoids discussion of the earlier development of these initial forms as being "too speculative." Here again we are brought face to face with one of those fundamental differences in point of view for which there seems to be no common denominator.

PRESTON E. JAMES

EUROPE

Land Settlement in Latvia and Its Application in Germany. An analysis and appraisal of the post-war agrarian movement in Latvia are attempted in a study by Drs. H. J. Seraphim and H. Wollenweber entitled "Siedlungstempo und Siedlungserfolg" (*Berichte über Landwirtschaft*, Suppl. No. 75 (N.S.), 1933). The authors sought to determine whether or not the methods utilized in the settlement of the newly subdivided landed estates confiscated by the national government after the estab-

lishment of Latvian independence could be interpreted as successful and whether they might be applicable to the settlement of certain forested areas in Germany. In Upper Silesia there is in the forest region some cultivable land that might well support many families. A few other localities now forested, it seems, would lend themselves to profitable occupation after clearing, if properly handled.

The success of the Latvian effort is acknowledged, but, before an attempt is made to adopt the system in Germany, certain contrasts between the two countries must be recognized. The Germans are a gregarious people, and, for the most part, the peasantry is accustomed to a somewhat higher standard of living than that of the Latvian peasantry. German tradition involving village life for farmers could not easily be broken down in favor of isolated dwellings upon scattered holdings. Again, the German settler would not be content to live upon so simple a diet and under such primitive physical conditions as those to which the Latvian readily adapts himself.

As a result of these differences, largely temperamental, the German government would be obliged to render much more assistance to its settlers in the initial stages of the land movement than the Latvian government has found necessary to supply. Hence, viewed from the standpoint of monetary investment, there is some doubt as to the probable success of such a movement. In any event, the authors recognize the German as a weak colonizer, who cannot be counted upon to settle uncleared lands, with the accompanying hardships, unless he is one of a group well supported by his government. This difference between the German and the Latvian is one of the important conclusions derived from observing the Latvian land reform.

In Latvia the family is an essential unit. The work of the farm is divided among its members, among whom are often included married children and their families. In the winter season the farm income may be supplemented by one person's engaging in furniture manufacture, another in weaving, and others in other types of handicraft. Thus the Latvian family manages to earn a living upon an acreage far smaller than, in the authors' estimate, would satisfactorily support a German family.

Wollenweber presents detailed statistical data relative to land uses before and after the agrarian movement. The activities of state and individual are portrayed. From this material he seeks to set up theoretical conclusions with respect to the fundamentals of settlement. Seraphim follows with a qualitative consideration of the actual mode of settlement, citing concrete cases. Wollenweber emphasizes, as essential to successful land settlement, a voluntary attitude and spirit of coöperation on the part of all persons concerned and cautions against political interference for selfish purposes. Seraphim shows how this spirit of willingness is exemplified by the settlers.

EUGENE VAN CLEEF

The Volcanic Region of Central Spain. Extending over an area of some 6000 square kilometers in the province of Ciudad Real—territory for the most part isolated and of no great economic importance—the volcanic region of central Spain is interesting physiographically and geologically (Francisco Hernández-Pacheco: Estudio de la región volcánica central de España, *Memorias Acad. de Ciencias Exactas, Físicas y Naturales de Madrid, Serie de Ciencias Naturales*, Vol. 3, 1932, with geological map on a scale of 1 : 100,000 in separate case). Southward the area drains to the Guadalquivir; it is crossed and dissected in the north and center by the Guadiana and its tributaries. There are two distinct types of topography—the one of rugged features, composed of heavily fractured Paleozoic rocks; the other of flat plains, Tertiary and Quaternary. The rugged country is truly inhospitable to man. Covered with thickets of xerophytic growth, the haunts of the wolf, fox, and lynx, it is frequented only by wood gatherers, charcoal burners, and huntsmen. The flat lands, on the other hand, are inhabited. Here decomposition of volcanic

materials has contributed toward a fertile soil for cultivation of wheat and rye and for olive groves.

The history of the volcanic formations goes back to the earth movements that built up the great Hercynian mountain ranges and originated planes of structural weakness along which volcanic masses were later to break through. Folding and faulting at this time were generally northwest to southeast in direction, and, whereas tectonic movements of the Tertiary—those that produced the Alps and Pyrenees—developed fractures in opposite directions, the original system of faults was rejuvenated by still later disturbances, prior to the volcanic display.

Eruptive activity appears to have begun toward the end of the Pliocene and to have continued with increasing intensity into the Quaternary. Volcanism became dormant during recent times, and only its last remnants in the form of warm springs and carbon-dioxide emanations now remain. Eruptions ranging from the tranquil to the explosive type are indicated by the character of the deposits. At many of the vents the action began and ended with a single outpouring of molten materials; at others there were multiple eruptions separated by relatively short intervals of time. Outbreaks of the tranquil type produced the numerous dome-shaped hills (*cabezos*)—lava cones that have resisted erosion; other eruptions built up cinder cones, which were more vulnerable. All have disappeared, while the lava streams that issued from their flanks remain. The ashes from these eruptions that settled over the adjacent plains have, for the most part, weathered beyond easy recognition, although some are found well preserved in clayey soils. Still another type of eruption, characterized by frequent gaseous emanations, produced scoriæ in abundance, with volcanic bombs up to a cubic meter in size. Finally there was the violent explosion that cast forth broken masses of sedimentary rocks as well as igneous materials and originated a crater that now contains a lake. The few fossils that have been found help to date the eruptions; and, judging from the masses of volcanic materials above the fossils, it seems probable that the eruptions reached into the age of paleolithic man.

W. E. RUDOLPH

AFRICA

Water Supply and Allied Problems of Bechuanaland. On the tribal reserves of Bechuanaland, comprising some 100,000 square miles, "there are on the average two natives, 7½ cattle, and five small stock per square mile. This cannot be called overcrowding . . . Yet much of the available land is over-grazed, owing to large areas being so scantily supplied with water that cattle have to be concentrated near such water supplies as there are." Water is the dominant problem in the protectorate whose affairs have become so critical as to call for a special governmental inquiry. The findings of the commission have recently been published as "Financial and Economic Position of the Bechuanaland Protectorate" (Cmd. 4368, London, 1933). The quotation with which we begin is from a discussion of the report by Leonard Barnes in the October, 1933, number of the *Journal of the African Society*. The report itself under the rubric of possibilities of development says: "At every stage of our inquiries, whether they related to agriculture, to cattle, or to human health and amenities, we realized that the absolutely essential condition to any progress was the improvement of the existing water supplies and the provision of new supplies. It is no empty form that the tribal greeting at the end of any ceremonial proceedings is in the words 'Pula, Pula'—'Rain, Rain.' " Tshekedi Khama, the acting paramount chief of the Bamangwato lately so much in the public eye, who contributed a valuable memorandum to the commission states that there are 744 places with water supplies "of some kind" in his reserve, but this is for an area of 40,000 square miles.

The water problem is an ancient one. It appears to be at least partly responsible

for the peculiarly concentrated native settlements so unlike the common Bantu form. Serowe, for instance, the capital of the Bamangwato, has a population estimated at between 25,000 and 30,000. The Bechuanaland "towns" are, however, merely clusters of villages: each section has its own arable lands, which may be up to 10 or 15 miles distant from the central "stadt," and the people live on them from November to May. The grazing grounds are separate and may be in an entirely different direction: the herds are in charge of young men and boys. The problems involved in this type of settlement are manifold. A first step towards solution must be a general water survey with a beginning of improvements in the shape of dam and well construction. This is the first recommendation of the report. It is also recommended that the work of clearing the river channels in the fertile land of the Okavango delta be continued. Other measures mainly concern the cattle industry, the mainstay of the country—improvement of breeds, investigations on the native grasses, the preparation of hides and skins. Markets and routes for cattle constitute another problem. The Walvis Bay railroad (compare "The Benguela Railroad and the Projected Line to Walvis Bay," *Geogr. Rev.*, Vol. 23, 1933, pp. 494–496) is ruled out as an impossibility unless "the position is changed by mineral discoveries." The report quotes Du Toit's advice of aerial reconnaissance to trace "ancient and now dry channels and pans" as the best basis for the establishment of a cattle route across the central Kalahari.

The pastoral products of Bechuanaland, virtually the only source of native income, do not bring enough to balance expenditures against importations and taxes. The deficit is met by "the sale of the labor of the able-bodied males" outside the protectorate and chiefly in the Transvaal. "Labour Migration From a Bechuanaland Native Reserve" by Dr. I. Schapera (*Journ. African Soc.*, Vol. 32, 1933, pp. 386–397) enlarges on the economic motive compelling migration and presents extremely interesting documentation in the shape of letters sent home by a young man working on the Witwatersrand (translated from the original SeKxatla). The migration movement raises another profoundly difficult question, which, in its broad aspects, has been so ably analyzed by Major G. St. J. Orde Browne in "The African Labourer" (1933).

The Europeans in Bechuanaland numbered 1743 in 1921 and were settled on some 7500 square miles (deducting this and the native reserves, the remainder of the territory—the most arid part—is crown land, unoccupied and undeveloped). Aside from the isolated Ghanzi settlement in the northwest, the whites are confined to a narrow strip along the eastern border. The protectorate is distinctly not suitable as "an agricultural venture for Europeans, where wages have to be paid."

ASIA

The Tide in Japanese Waters. In connection with hydrographic and other surveys made by the Japanese government tides have been observed at a large number of places along the coasts of Japan, the results being published in various journals and reports, but largely in the Japanese language. A comprehensive study of these tides in a Western language was thus a great desideratum. This need has now been met by Dr. S. Ogura in a publication entitled "The Tides in the Seas Adjacent to Japan," which appears as Volume 7 of the *Bulletin of the Hydrographic Department, Imperial Japanese Navy* (1933).

The tidal data are given in the form of harmonic constants. One table lists the four principal constants for more than 700 places along the coasts of Siberia, Japan, Manchukuo, and the islands of the Eastern Archipelago, while a second table gives the full list of constants for some fifty of these places. The locations of the stations at which the tide observations were made are indicated on charts. The principal features of the tide in each region are discussed and typical tide curves shown.

On the basis of the harmonic constants listed, Dr. Ogura has drawn cotidal charts for the M_2 and K_1 components and co-range charts for $K_1 + O_1$ and $M_2 + S_2$. These give a comprehensive view of the progress of the tide in these waters and the variations in the tropic and spring ranges. Along the Pacific coast of the Japanese islands the tide progresses in simple fashion from east to west, but in the nearly landlocked seas washing the western shores of these islands the tidal movement is much more complex, a number of amphidromic points being shown, about which the cotidal lines rotate.

In the Okhotsk Sea the tide is particularly interesting, for here are found daily tides with unusually large ranges. And, as Dr. Ogura notes, no theory of the tides in the Okhotsk Sea has yet been established. Another extremely interesting tide is that on one of the Caroline Islands, in which the solar component is larger than the lunar, so that the tide occurs about the same time each day, instead of becoming later by about 50 minutes, which, with but few exceptions, is the usual course of the tide the world over.

The tidal currents in these regions are discussed by Dr. Ogura,and a chart giving the co-current hours and the velocity of the current is included. He also takes the opportunity to discuss the variations in sea level from year to year, listing these variations at a number of places for the thirty-year period from 1900 to 1929. The publication is an important addition to our knowledge of the tides in this part of the world.

H. A. MARMER

Glaciers of the Shayok, Nubra, and Karakash Basins. The Dutch explorer Dr. P. C. Visser, who holds the position of Consul-General of the Netherlands in Calcutta, continues in "De gletschers in de stroomgebieden van de Shyock-, Nubra- en Karakash-rivieren" (*Tijdschr. Kon. Nederl. Aardrijksk. Genootschap*, Ser. 2, Vol. 50, 1933, pp. 681–726) his valuable descriptions of the glaciers of the Karakoram. A general review of the ice-and-firn cover in these highly elevated regions shows that the position of the snow line varies between 5000 and 6000 meters within the different mountain ranges; in each range it drops from 500 to 700 feet on the northeastern flank of the range. Exceptions to this rule are the main Himalayan and Karakoram ranges, for both show a southwesterly dip of the snow line. This feature clearly indicates that here its position is determined by the monsoon track from India to Central Asia.

Lamination of glacier ice is believed to result from shearing strain, in a similar way, I gather, to that in which exfoliation of rock fabric results from minute slipping and molecular rearrangement in the plane of dominant shearing. Annual ablation amounts to an average of 2.42 meters for the total surface of the larger glaciers. Glacier movements are irregular. In some cases the tributary glaciers help to balance the retreat of a main glacier, as in the case of the Siachen, which is 75 kilometers long and which has a total surface of 1150 square kilometers. An example is given of a remarkable glacier advance in the Nubra Valley, where a single glacier has moved more than one mile since 1914. In this case gliding between layers of different density seems responsible for the advance, which was released by a sudden breaking loose of the larger firn cakes in the feeding region. Dr. Visser's observations deserve the greatest consideration of glaciologists.

H. DE TERRA

New Political Subdivision of Outer Mongolia. A lengthy article on Outer Mongolia is included in Volume 3 of the Siberian Soviet Encyclopedia, recently issued (Novosibirsk, 1932?). According to this article, the government of the "Mongolian People's Republic" issued a decree dated January 6, 1931, giving the new scheme of administrative division of the country.

Formerly Outer Mongolia was divided into five aimaks, or provinces, made up of

72 hoshuns divided in turn into somons. Under the new law the republic is divided into 13 administrative-economic units, or aimaks, comprising 324 somons. The somons are divided into horins, the horin constituting the basic unit of organization. These 13 new aimaks or provinces also replace the division of the country, formerly in force, consisting of 6 trading and 8 veterinary districts.

FIG. 1—New administrative divisions of Outer Mongolia.

The above scheme does not embrace 3 national hoshuns in the aimak of Kobdo. These hoshuns, which have been left as exceptions to the national administrative system of subdivision, are Uriankhai, with 3 somons, and 2 hoshuns inhabited by Khirgiz, comprising 7 somons. The direction of all political and economic life in each aimak is concentrated in the center or capital. The work of all economic institutions and organizations throughout the republic has been reorganized to conform with the new scheme of political and administrative division of the country.

N. N. KRIJANOVSKY

AUSTRALASIA AND OCEANIA

Lakes of the Central Plateau of Tasmania. Earlier investigators of the Central Plateau of Tasmania had come to the conclusion that glacial evidence was almost absent in that region. Dr. A. N. Lewis, however, who has been working on the topography of Tasmania for many years, shows in a "Note on the Origin of the Great Lake and Other Lakes on the Central Plateau" (*Papers and Proc. Royal Soc. of Tasmania for the year 1932*, pp. 15–38) that almost the whole plateau (above 3000 feet in the east and above 2400 feet in the west) was covered by a fairly continuous if shallow ice cap during part of the Pleistocene. This sheet of ice had an area of about 2000 square miles and covered the site of the Great Lake, the source of most of the hydro-electric power in Tasmania. Owing to the flat topography and the hard dolerite of the plateau surface there has been no extensive deposition of ground moraine—hence the advantage that the surface rocks offer good dam sites. The large lakes, in the opinion of Dr. Lewis, are not dammed by moraines but are slight nivation hollows, perhaps helped by recent earth movements. The reviewer has discussed elsewhere similar nivation phenomena in Tasmania and has compared them with other glaciated regions southwest of the Pacific (see Glaciation in the South West Pacific, *Proc. Third Pan-Pacific Sci. Congr., Tokyo, 1926*, Vol. 2, pp. 1819–1825).

A physiographic explanation of the postglacial gorge of the Ouse (1200 feet deep) closes this interesting contribution to Tasmanian topography. GRIFFITH TAYLOR

The Hawke's Bay Earthquake. Though New Zealand has a considerable seismic history, earthquakes in that country have not generally occurred at a time or place to do serious damage to life and property (J. Henderson: Earthquakes in New Zealand, *New Zealand Journ. of Sci. and Technol.*, Vol. 14, 1932, pp. 129–139). The Hawke's Bay earthquake of February 3, 1931, however, was "on a scale without parallel in New Zealand, and constitutes the greatest disaster which has affected the Dominion since its foundation." The shock was of extreme intensity—it was felt for as great a distance as the Japanese earthquake of 1923—and the area about Hawke's Bay, exceedingly fertile, is closely settled: its towns include Napier (16,025) and Hastings (10,850). The loss of life is estimated at approximately 260: the loss to property may be gauged from the £2,500,000 paid by the government and by insurance companies "in respect of damage done."

The July, 1933, number of the *New Zealand Journal of Science and Technology* (116 pp.) is devoted to the earthquake in its various aspects. Dr. J. Henderson, director of the New Zealand Geological Survey, reports on the geology, including surface effects. A marked recession of the sea, which at first caused apprehension of a tidal wave, was due to uplift of the land. "The uplift of the coast at Napier and northward indicates deep-seated movement, and the fissures and ridges in the downs immediately south of the Heretaunga Plain mark where the earth-fractures reach the surface. The course of the fracture-zone northward and the movements that took place along it are indicated by changes in the heights of points levelled, prior to the earthquake, along the railway and on the closely settled Heretaunga Plain."

The large number of aftershocks with epicenters in the bay suggests gradual adjustment from unstable conditions caused by the main shock in the sloping ocean bed to the eastward. A map of seismic intensity and a map of the epicenters in Hawke's Bay are given in the seismological report. Other noteworthy features among the excellent illustrations are a block diagram of the region, maps of the damage in Napier and Hastings, an insert map showing changes of level, pressure ridges, and earth rents, and many photographs of surface features and damage to buildings. The last-named matter—damage to buildings—is particularly interesting in connection with Professor Davis's article on the Long Beach earthquake (pp. 1–11). It reënforces the need for a "seismic architecture" in regions subject to earthquake risk. "That appalling loss of life and property was directly due to obvious errors in the design and construction of some of the buildings was most evident to all who visited Napier and Hastings immediately after the earthquake, and there is every reason to believe that similar constructional weaknesses would have been revealed had the earthquake occurred in any other densely populated area in the Dominion. It should be understood that though varying standards of building construction had been adopted in the past by different local authorities, these bodies in many cases felt that there was some need for revision of their codes. However, in the absence of expert guidance concerning the construction of buildings on lines adequate to withstand reasonably well the stresses arising from earthquakes, this revision generally had been postponed." To supply this guidance a Building Regulations Committee was created and a "Building Construction Bill" has been introduced into the New Zealand Parliament.

An article in the October, 1933, number of the *Bulletin of the Seismological Society of America* by Cornelius G. Dahm deals with the "Epicenter of the Hawke Bay (New Zealand) Earthquake and Travel-times of Condensational Waves."

POLAR REGIONS

Two Antarctic Expeditions. The season of 1933–1934 will see a renewal of activity in Antarctic exploration in the expeditions of Mr. Lincoln Ellsworth and Rear Admiral Richard E. Byrd. Mr. Ellsworth terms his expedition "purely a voyage of

discovery." He intends to make a single nonstop flight of 2900 miles from a base on the Bay of Whales on the Ross Sea to the Filchner Shelf Ice on the Weddell Sea and return. He hopes that such a reconnaissance flight will solve the outstanding problem of the Antarctic: whether "the great oceanic indentations that form the Weddell Sea on the one side and the Ross Sea on the other continue as a trough, perhaps below sea level, dividing the Antarctic Continent into two rugged land masses, or . . . the mountains of Graham Land, which rise to 10,000 feet, continue across the continent to join the Queen Maud Range."

To carry out this program of exploration Mr. Ellsworth has obtained a specially constructed Northrop monoplane. Only two men will make the flight, Mr. Ellsworth as navigator and photographer and Mr. Bernt Balchen as pilot. Oblique and vertical pictures will be taken with Zeiss cameras, and a continuous photographic record will be made with a clock-operated camera taking photographs every six seconds. Radio equipment will be carried enabling the monoplane to maintain contact with the base ship, the *Wyatt Earp*. This vessel with its crew of fifteen men left Norway on July 30, reached Dunedin via Cape Town on November 10, and left for the Antarctic early in December. Sir Hubert Wilkins will report the expedition. Should weather conditions be favorable so that the flight can be made immediately, the expedition will probably stay at the Bay of Whales for little more than a week. However, the expedition is outfitted with emergency supplies for a year.

Rear Admiral Richard E. Byrd, leader of a second expedition to the Antarctic, plans to spend a year at his old base of Little America on the Bay of Whales. Therefore his preparations are quite extensive. To transport his personnel of seventy men, the dogs, airplanes, and scientific equipment, as well as the large quantity of stores, he has obtained two ships. One of these is the famous U. S. Coast Guard cutter *Bear*, and the other is a cargo vessel, the *Jacob Ruppert*. These vessels, bound for the Antarctic, passed through the Panama Canal on November 12 and October 30, respectively.

Rear Admiral Byrd is taking with him a twin-motored Curtiss-Condor seaplane and an autogiro. In addition, he hopes to salvage the two airplanes left behind at Little America in 1930. With this aerial equipment he plans a number of flights; one over the South Pole, one across to the Weddell Sea, one to the South Magnetic Pole, and further aerial exploration of Marie Byrd Land. In addition, the scientific program is very broad. It includes studies in geology, glaciology, mineralogy, meteorology, oceanography, and biology. Special work will be done in geophysics and in cosmic-ray intensities. The experimental radio program is also comprehensive.

WORLD AS A WHOLE AND LARGER PARTS

Mountaineering in Scotland and in the Northeastern United States Contrasted. The Scottish Mountaineering Club has published an excellent series of guidebooks, the most recent numbers of which are "Island of Skye" (edited by E. W. Steeple, G. Barlow, and H. MacRobert, 1931), "The Western Highlands" (by James A. Parker, 1931), "The Cairngorms" (by Henry Alexander, 1931), and "The Northern Highlands" (by W. N. Ling, 1932). They bring to mind contrasts between mountain climbing in Scotland and in the northeastern United States—contrasts that arise partly from differences in the mountains and partly from dissimilar social and economic conditions.

Although not so high, the Scottish Highlands have many more alpine features than our White Mountains or Adirondacks. Slice off the uppermost 3251 feet of an Alpine massif, set it down at sea level, melt away the glaciers and snow fields, and you will have a range resembling the rugged Cuillin hills of Skye. In the northern and western Highlands there are not a few mountains—like the striking Suilven—that rise precipitously on all sides. The summits of the Cairngorms and

of Ben Nevis form the highest parts of wide, plateau-like surfaces, but on these surfaces corries, or glacial cirques, have been etched on a far grander scale than is to be found in their counterparts of the Presidential Range and Katahdin. In the corries and on the exposed ridges the snow in winter and spring forms névés and cornices closely akin to those of the Alps, and snow avalanches are not uncommon. These features have given rise to types of mountain climbing almost unknown in the eastern United States—rock climbing and snow climbing, with the elaborate techniques that have been brought to perfection in the Alps and the Canadian Rockies. As in these loftier ranges, many of the crags and pinnacles in Scotland have long resisted attempts to scale them, and the guidebooks make much of the records of "first ascents" and ascents by particularly difficult routes. For this kind of mountaineering the mountains of New England and New York offer practically no scope whatever. On the other hand, an almost complete absence of forests in the highlands has meant that the techniques of woodcraft and trail cutting have played no part in Scottish mountaineering. The American climber regards the forests as one of the main elements that give charm to the mountains. A British mountaineer finds charm in heather and rocks and writes of the Cuillin that "their sides are not disfigured with monotonous pine forests of a uniform light green colour."

In the parts of the Highlands covered by these guidebooks mountaineering would seem to be preëminently the sport of the "gentleman and scholar." The guidebooks themselves bear silent witness to this, with their discussions of geology, meteorology, botany, and place names, their historical allusions and their bibliographies, their quotations from poems, and their literary flavor of good sportsmanship. "Gentlemen and scholars" also visit the White Mountains and Adirondacks, but in addition and in ever increasing numbers come climbers of all ages and kinds. The American mountains are somewhat nearer the main centers of population. Whereas Mount Washington is only 280 miles from New York, Ben Nevis is 410 miles from London. The almost universal use of the automobile and the extensive development of that peculiarly American institution, the summer camp, bring trampers to our mountains from all over the country. Our mountains, moreover, are open to visitors at all times of the year. Most of the tracts not included in the national forests belong to lumber companies, which have no objection to trespassers. In Scotland during the most favorable climbing season—late summer and autumn—the public is excluded from widespread mountain and moorland areas set aside as deer and grouse preserves.

Study of the Quaternary in Russia. The second international conference of the Association for the Study of the Quaternary Period in Europe was held in Leningrad in September, 1932. It included sessions in Leningrad and Moscow, excursions in the vicinity of Leningrad, and a 20-day trip in southern Russia. For this conference the Soviet glacialists prepared a map on the scale of 1 : 2,500,000 of the Quaternary of the European part of the U. S. S. R., a detailed guidebook, and a great many papers dealing with all phases of glacial geology.

The Soviet government has a keen interest in the Quaternary for both economic and educational reasons (see the addresses by I. M. Gubkin, president of the Association, in the *Transactions* of the Conference, Part 1, pp. 16–27, and Part 4, pp. 21–30). The Quaternary deposits supply raw materials for buildings, roads, railroads, dams, canals, etc.; they form the substratum for such constructions; they serve as reservoirs for water; they supply fuel in the form of peat; and they constitute the parent rocks of the soils. Their gainful utilization calls for all-round practical and theoretical studies. Regardless of the economic importance to the state, scientific investigations of the Quaternary are justified by the knowledge and philosophical teachings they convey and especially by the light they shed on the environment in which man rose and evolved. The study of ancient man, of his implements, cultures, social organizations, and slow rise, is of great human and social significance.

The map issued for the conference was compiled by several geologists under the direction of S. A. Yakovlev. To secure data for its completion no less than 15 special field parties were sent out in 1930 and 1931. The map is primarily genetic, i.e. the genesis of the deposits is the basis of classification and division and of the color scheme. Divisions and names differ in some respects from those usually accepted in Western Europe and in North America, but they seem to be both logical and practical. The choice between such terms as glaciofluvial (or better, glacifluvial—Gerard De Geer, 1909) and fluvioglacial offers difficulties. Since a genetic term is wanted, and since "glacifluvial" signifies the process or deposit of a glacier river while "fluviglacial" signifies the process or deposit of a river during glaciation, glacifluvial is preferable. So, too, are the terms "glacilacustrine" and "alluvilacustrine." One important feature, the morainic deposits, has been shown on a second map, discussed by Yakovlev in a special paper (*Trans.*, Part 1, pp. 80–93).

The importance of "microstratigraphy" (geochronology and micropaleontology) for correlation of Quaternary deposits is stressed by Helmut Gams (*Trans.*, Part 1, pp. 41–42), who at the same time touches the uncertainty of even generally accepted divisions and correlations. The organic sediments of deep lakes, which may give continuous profiles covering very long ages, are particularly promising.

The lower limit of the Quaternary, the division of its deposits, and their correlation are discussed at some length by A. M. Girmounsky (*Trans.*, Part 1, pp. 63–79), who includes in the period a preglacial (pre-Günz) age of falling temperature. The term "Quaternary," meaning "of the fourth order or rank," is, in Girmounsky's opinion, antiquated and should be replaced by the name "Anthropozoic," meaning "human life," which should be given the status of era, while "Cenozoic" should be restricted to the Tertiary. The fact that after a hundred years the name Quaternary is exclusively used in some countries and Pleistocene almost exclusively in others shows that neither of them will be generally accepted: both terms should be discarded in favor of a better name. Stressing the importance of dating and correlation on the basis of all known conditions relating to flora, fauna, climate, crustal movements, human culture, and so forth, Girmounsky attempts, in a table, a correlation of the major Quaternary epochs and ages in the northern hemisphere. While his aim—a truly international division—is laudable, certain points do not seem to have been duly considered. A division applicable to North America as well as to Europe and Asia and to low and high as well as to intermediate latitudes clearly must be founded on a condition or conditions prevalent in the entire or almost the entire northern hemisphere. It cannot be based on a regional climate as is, for instance, the "Boreal Age." But it probably could be founded on long-continued and great changes in the summer temperature, as discussed by the reviewer (*Sixteenth International Geol. Congress, Abstract of Papers*, Washington, 1933, p. 4). As emphasized by Girmounsky, one international name for each division is desirable. However, until we know positively that two divisions (for instance, the Illinoian glaciation in North America and the Riss in the Alps) were correlatives, we have to use both names. Furthermore, the Pleistocene, a term universally used in English-speaking countries for the entire last ice age or the entire Quaternary, should not be applied to the Riss-Neowürm age, as is done by Girmounsky. Finally, an old name, "Holocene," which has proved its unfitness by its desuetude, should not be revived as a substitute for "postglacial," which is almost universally accepted.

The excursions of the conference (Guide Book and *Trans.*, Part 4, pp. 23–43) touched many important problems such as late-glacial and postglacial shore lines and marine Arctic beds near Leningrad; Riss-Würm interglacial beds near Moscow and in western Russia, which testify to marked climatic changes and to an age warmer than the present; the loess in the Ukraine, its stratigraphy, and its fossil soils; and the former glaciations of the Caucasus, which appear to be fully parallel to those of the Alps.

The proceedings as a whole show that during the last few years Quaternary geology has made a truly remarkable progress in the Soviet Union.

ERNST ANTEVS

PHYSICAL GEOGRAPHY

Stray Sea Birds and Atlantic Storm Tracks. Strictly pelagic birds, especially members of the petrel group, are occasionally picked up at inland localities. As ornithological phenomena, such records usually either are "unaccountable" or are loosely correlated with the occurrence of oceanic storms.

Numerous waifs sent for identification to the American Museum of Natural History during the late summer of 1933 point to a definite relationship between sea-bird records from northeastern North America and the birthplace and course of the tropical storm of late August. All the specimens referred to below have been examined by the writer.

South Trinidad petrel (*Pterodroma arminjoniana*). An example found alive at Caroline Center, near Ithaca, N. Y., August 26, 1933. The species breeds only at Trinidad Islet and the neighboring Martin Vaz Rocks, in the tropical South Atlantic. It has previously been collected but once at a distance from its nesting ground and never before in North America.

Madeira petrel (*Oceanodroma castro*). One found alive in the streets of Ottawa, Canada, August 28, 1933. The species breeds in the Azores, the Madeira region, the Cape Verde Islands, Ascension, and St. Helena. It does not normally occur in the western North Atlantic, though a few stray examples have previously been taken in the eastern United States.

Wilson's petrel (*Oceanites oceanicus*). One taken on Lake Titus, Malone township, N. Y., altitude 1396 feet, August 26, 1933. The species breeds only in subantarctic latitudes but is abundant during the summer off the North Atlantic coast of the United States.

Leach's petrel (*Oceanodroma leucorrhoa*). Remains of 19 specimens, more or less disintegrated, found at Sylvan Beach, Oneida Lake, N. Y., September 7, 1933, and subsequently. The species nests on islets off our Atlantic coast, from Penikese, Mass., northward to Greenland.

During the last few days of August various unidentified small petrels were reported as "sight records" at Binghamton and Cayuga Lake, N. Y. All the petrels are pelagic birds that never voluntarily fly over the land except while passing to and from their insular nesting sites.

It is suggestive to note how the records cited correspond with the meteorological occurrences of the latter half of August, as summarized by Dr. C. F. Marvin, chief of the U. S. Weather Bureau.

The tropical disturbance that crossed our Atlantic coast near Cape Hatteras during the night of August 22 originated not far to the southwest of the Cape Verde Islands about August 14. It first moved westward for several days and then, when from 250 to 300 miles northeast of the Leeward Islands of the Lesser Antilles, turned northwestward, passing about 150 miles south of Bermuda. It next switched more toward the west and reached Washington, D. C., on the evening of August 23. By this time a definite recurve had begun, and the subsequent movement was north-northeastward to the mouth of the St. Lawrence River.

The area of gales up to August 17 was probably not more than from 25 to 75 miles in diameter, with the cloud and rain area somewhat greater. From August 20 to 23 the area of gales was from 300 to 400 miles in diameter and the cloud and rain fringe larger in proportion.

We have no means of determining the particular locality in the Atlantic at which, for instance, the cyclonic storm seems to have whisked up a whole flock of Leach's petrels, to transport the birds to Oneida Lake or its vicinity. But the South Trinidad

and Madeira petrels obviously must have been carried a very long distance. It may appear far-fetched that strong-winged sea fowl should have been held in durance by a storm of such relatively small area, the more so since the system of storm winds traveled at a rate of only 15 or 16 miles an hour. However, winds of high velocity prevailed around the center, and both the storm track and the dates point strongly to a causal connection between the meteorological phenomena and the inland records of the species from the southern and eastern hemispheres. Theoretical improbabilities, moreover, are minimized by the very rarity of such ornithological records.

For a long period, and with considerable fullness of data, the occurrences of sea-bird waifs in eastern North America have found their way into literature. A comparison of each available record with contemporary information relating to the antecedents of Atlantic coastal storms might add measurably to our knowledge of the origin and tracks of such disturbances.

ROBERT CUSHMAN MURPHY

HUMAN GEOGRAPHY

Problems of Population. "Though we are not prepared to turn to the ant, or even to the lily of the field for examples of correct human social behaviour, we are not unwilling to turn to the rabbit in our attempts to gain a proper understanding of the origin and destiny of empires." Thus Professor F. A. E. Crew, of the University of Edinburgh, introduces "The Biological Aspects of Migration" in the first number of *Population* (June, 1933). "I wish to suggest that human migration is a biological phenomenon that has been exhibited by a great number and variety of human stocks; that migration has a meaning in biological philosophy; and that, therefore, in any political discussion relating to migration, certain biological principles have to be recognized. . . . Vast areas in East Africa are presently being exploited by white men who cannot colonize them. Under the conditions which obtain there the white cannot compete, reproductively or economically, with the migrants from India. India is now exhibiting the phase of migration, and there is only one region where the migrants can find a new habitat with agreeable conditions and sparsely populated, and this is East Africa. I am not at all concerned with political considerations, but to me, a biologist, it seems that nothing is more certain than that no purely political attitude can continue to withstand the inevitable fact that a habitat will sooner or later be the possession of the biologically most appropriate stock. . . . It seems to me that we have to accept the fact that just as we and other peoples swarmed years ago, so now the Indians, the Japanese, and the Chinese, for the same reason that they, as we, are animals who, under certain circumstances, exhibit characteristic reactions, are exhibiting this migratory urge. . . . Unless we can prevent the causes that lead up to migration, we cannot prevent migration. . . . The only real solution is that a population living in an appropriate habitat shall so fashion the conditions of this habitat that they will be as 'comfortable' as possible to all the various biological types in the population; and that the reproductive rate of the population as a whole and of its component types shall be so controlled that the numbers of a population are in constant accord with the environmental opportunities for their support."

The above quotations outline the argument of a stimulating paper that with other excellent contributions—including G. H. L. F. Pitt-Rivers on "The Urgency of Population Study from the Bio-anthropological Approach" (defining "human ecology" or "ethnogenics"), A. M. Carr-Saunders on "An Outline of Population History," and Sir Charles Close on "A Brief Review of the Present Population Situation in South and East Asia"—makes justification of the new journal, the organ of the International Union for the Scientific Investigation of Population Problems. The wide scope of the Union is well illustrated in the volume "Problems of Population" (edited by G. H. L. F. Pitt-Rivers), reporting the proceedings of the second general assembly, which met in London in 1931 under the presidency of Colonel Sir Charles

Close. This volume, it may be noted, begins on an auspiciously geographical note with a "Scheme for a Population Map of Great Britain" by Captain J. G. Withycombe.

OBITUARY

Major C. K. Cochran-Patrick; Lieutenant George R. Johnson. Aerial photography has recently suffered the premature loss of two of its distinguished exponents.

Major C. K. Cochran-Patrick was killed in a plane crash near Johannesburg on September 26 last. Readers of the *Geographical Review* (April, 1931) will recall his account of the methods used in his important air survey in Northern Rhodesia, "Aerial Reconnaissance Mapping in Northern Rhodesia," a survey that covered more than 70,000 square miles. Major Cochran-Patrick had also conducted an air survey for irrigation and settlement in Iraq, respecting which the *Geographical Journal* observes: "He also possessed an extraordinary flair for country. He photographed, with verticals, some 1000 square miles in 'Iraq without a gap, no small achievement in a country so devoid of landmarks." Earlier he had demonstrated the value of aerial survey in the mapping of such difficult terrain as the Orinoco and Irrawaddy deltas.

Lieutenant George R. Johnson was killed in a plane crash at Red Bank, N. J., on November 5 last. In his official capacity as Chief Photographer of the Peruvian Naval Air Service, 1928–1929, Lieutenant Johnson had made a remarkable collection of photographs of the Peruvian landscape. A selection of these, described by legends and notes and with an introductory chapter by Raye R. Platt, was published as "Peru From the Air" (*Amer. Geogr. Soc. Special Publ. No. 12*, 1930). It was to investigate certain interesting features exhibited by these photographs that the Shippee-Johnson Peruvian Expedition of 1931 was organized. The results were presented in the *Geographical Review* as "The 'Great Wall of Peru' and Other Aerial Photographic Studies by the Shippee-Johnson Peruvian Expedition" (January, 1932) and "Lost Valleys of Peru: Results of the Shippee-Johnson Peruvian Expedition" (October, 1932). On this expedition Lieutenant Johnson was co-leader and photographer.

GEOGRAPHICAL REVIEWS

A New Viewpoint in Climatology

H. C. Willett. **American Air Mass Properties.** *Papers in Physical Oceanography and Meteorology*, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, Vol. II, No. 2, 1933.

A new angle of the study of meteorology and climatology of this country has been illustrated by Professor Willett in his "American Air Mass Properties." For purposes of discussion he limits the paper to a treatment of the types of air masses which made their appearance during the opposite seasons of December 1929–March 1930 and July–August 1930. Both morning and evening weather maps were made for this study by the Meteorological Department of the Massachusetts Institute of Technology on which the extent and limits ("fronts") of the air masses were indicated as well as the physical characteristics. The data were taken from the observations of the United States Weather Bureau stations, a number of pilot-balloon stations, and nine aerological stations. During the two chosen periods all the major types of air masses were of such prominence, at one time or another, that careful analyses of the properties of each type of air mass were made.

An air mass is considered to be "an extensive portion of the earth's atmosphere which approximates horizontal homogeneity." Its formation requires a source region that may well be defined as a broad expanse of uniform surface where the air remains for a sufficient length of time to establish an equilibrium with respect to the surface below. The source regions that affect the American air masses are the snowy (winter) wastes of northern Canada, the warm waters of the Gulf of Mexico, the Caribbean Sea, and the tropical Atlantic Ocean, the cold western North Atlantic, the southwestern part of the United States and adjoining highland Mexico, the tropical Pacific, and the relatively warm North Pacific. From these source regions come two main types of air masses, one bearing the characteristics of the high latitudes, the other those of the tropics. These types, in turn, may be subdivided into continental and marine, the latter being differentiated according to the body of water that imparts to the air the distinguishing qualities. Thus, there are polar continental, polar Pacific, tropical Gulf, tropical Atlantic, etc. After leaving its source region, each of these masses undergoes modification and is then designated as transitional. In all, there are no less than a dozen types of air masses, each of which has a distinct type of weather.

Of the three types of polar air that command attention, the polar continental, or polar Canadian (Pc), is singular by reason of its low surface temperature. It has a marked temperature inversion extending to a considerable elevation and ascribable to radiational cooling at the snow surface. Also, there is a lack of movement to stir the upper air layers into isothermalcy. It is a descending and, consequently, a drying air with a very small moisture content. There are no clouds. However, at the surface, where the temperature is very low, the relative humidity is high, usually more than 90 per cent. When this type of air has built up a sufficiently high pressure, the southward outbreak occurs, particularly when a cyclonic disturbance of warmer air is crossing the United States. Then the Pc air floods the central portion of the United States and works its way eastward and southeastward: it rarely overruns the area west of the Front Range of the Rocky Mountains. Frequently the southward flow of cold air spreads over northern Texas—the well known "norther"—and occasionally reaches southern Mexico and the Gulf of Tehuantepec; the southeastward spread may bring freezing weather to Florida. In a southward journey the Pc air receives heat and moisture from the surface over which it travels, and the movement, especially over a rough undersurface, produces a thoroughly mixed lower stratum. This mass is then designated as modified or transitional polar continental

(NPC). The summer characteristics of the Pc air are markedly different from those of the winter, for the snow-and-ice cover is absent at the source region. Relative humidity is low, the temperature is moderately low, and such clouds as are formed are scattered, high cumulus forms.

The polar-Pacific (Pp) mass, though it originates in approximately the same latitude as the Pc masses, reaches the west coast of the United States quite warm and moist in winter because of its sojourn over the warm water of the North Pacific. Owing to its warmth and moisture content it is relatively unstable in the lower strata, and the cloud forms are typically low stratus and low cumulo-nimbus, bringing showers and long-drawn rains. After passing over the mountains, which wring the moisture from it, it descends on the Great Plains and makes its way eastward as clear, dry, mild weather. The effect of the mountains in changing the properties of this mass is of such magnitude that it is then designated as modified polar Pacific (NPP). The descent of this wind east of the Rockies produces the well known chinook wind. Radiational cooling takes place at a rapid rate, especially if the ground has a snow cover, because the air is quite clear. In summer the Pp air is relatively stable, and the stratus and cumulo-nimbus clouds and showers are definitely absent along the coast. Inland during the warmer months it is quite impossible, even at the aerological stations, to distinguish between the Pp and the Pc masses.

In late spring and early summer the normal eastward progression of air is often retarded by a high-pressure area that builds up over the cold water of the North Atlantic in the region of the Labrador Current. Such a situation brings to New England and the near-by coast of the Middle Atlantic states the cold, damp, east or northeast wind of polar-Atlantic (PA) origin. This mass closely follows the temperature régime of the ocean, seldom reaching a temperature as high as 60° F., even in late summer.

The tropical-continental (Tc) air is of little significance in winter but of major importance in summer. During this season the excessive heat of the ground is transmitted to the surface layers of air, which then become very unstable. However, condensation does not occur, for the air is very dry, and clouds are noticeably absent. This air mass is brought northeastward when a low is over the northern Plains. Just how far north the mass moves before losing its characteristic properties is problematical, but occasionally it can be definitely traced to the Dakotas and eastward to Illinois or Indiana.

The warm, moist tropical-Gulf air (TG) and the tropical-Atlantic air (TA) are in direct contrast with the hot and dry Tc air. These two masses are of prime importance to the central and eastern United States. Both are quite similar, different symbols being used only to note the general trajectory of the air mass, though the TA air is usually of less equatorial nature than the TG air: because of their similar qualities both may be designated as tropical maritime (mT). High temperature and high specific and relative humidity characterize these masses. The warmth of the lower strata, plus the moisture, results in a conditionally unstable structure, with frequent passing showers. As a mT mass moves northward over colder ground, it tends toward greater stability. But, even in winter, a long thrust north to the Great Lakes changes the properties but little because the high moisture content and the stratus clouds form an effective blanket preventing the escape of heat imparted to it by its warm source region. However, when the mass is lifted by an active underrunning cold, continental mass, heavy rains or snows occur at the line of discontinuity. In winter these masses are confined, for the greater part, to the Gulf and Atlantic states, though at wide intervals they invade the country east of the Mississippi River as far north as the Great Lakes. In summer these masses frequently reach the latitude of Lake Superior, for they are not hampered by cold, continental air or a snow-and-ice cover.

The source region of the tropical Pacific is suggestive of its properties: the weather

is prevailingly anticyclonic, resulting in moderately warm or even cool temperatures for tropical-maritime air, a stable lapse, a low humidity, and an absence of condensation forms. In the winter, when this type of air is forced to overrun Pp or Pc air, heavy rains occur along the California coast. In summer the Tp air plays a minor rôle in the weather of the Pacific coast but dominates the weather inland, for in the Great Basin and Rocky Mountain regions the summer low pressure produces a steady southerly wind for a prolonged period, with the result that much moisture is brought inland by the Tp air. Considerable cloudiness and widespread showers in this low are ascribable to the transport of this moisture by the Tp air.

To climatologists and meteorologists this paper is most welcome. It gives a clear conception of the types of weather and the underlying factors of the various types of climate from the viewpoint of air-mass analysis. It will be welcomed by geographers who aim to keep informed on meteorological and climatic interpretations that have a bearing on human activities.

PHIL E. CHURCH

A "RECENT SOCIAL TRENDS" MONOGRAPH

WARREN S. THOMPSON AND P. K. WHELPTON. **Population Trends in the United States.** x and 415 pp.; map, diagrs., index. (Monographs: Recent Social Trends in the United States.) McGraw-Hill Book Co., Inc., New York and London, 1933. $4.00. 9½ x 6½ inches.

The first of the contributions prepared under the direction of the President's Research Committee on Social Trends was that of Thompson and Whelpton on population, and that contribution has now appeared in book form with the tabular material that will be of assistance to those who are working in this field of research. As the authors and their institution, the Scripps Foundation for Research in Population Problems, are unexcelled in this country in their line of work, anything produced by them must be put down at once as authoritative from the technical point of view. The reason for the restriction is that Thompson is known to hold opinions about what is socially desirable in the way of population and of population policy, and the state of the science of population is not yet complete enough—and perhaps never will be—to guarantee the soundness of such opinions. Take, for instance, the statement: "Foreigners . . . hastened industrialization by supplying an abundance of cheap labor." This may be so: the author states it; he does not prove it. We have seen the contrary stated but not proved, namely that the necessity that is the mother of invention and that forced mechanization of our work was due precisely to our insufficient supply, despite immigration, of cheap enough labor! Fortunately, the discriminating reader will certainly, and even the general reader will probably, be able to differentiate between the authors' science and their opinions, and both will be glad that the work is neither all science nor all opinion.

The titles of the eleven chapters are: The Growth of Population in the United States, The Distribution of the Population, The National Origins of the White Population, The Age Composition of the Population, Sex Composition, Marital Condition, Deaths and Death Rates, Births and Birth Rates, Population Growth from Immigration and Natural Increase, Probable Trends and Consequences of Future Growth, and Population Policy. There are many tables in the text, and the volume has an appendix of tables running to 70 pages. It cannot fail to be for considerable time the standard text on the demography of the United States, indispensable to students of social phenomena. It is to be hoped that one result of the monograph will be that we shall have more and better trained demographers among us. Not so long ago a distinguished European practitioner of this science stated that one of the greatest desiderata for social science in America was the provision of traveling fellowships that would permit young social scientists to go from this country to Europe for a more thorough training in demography, which he regarded as basic to fundamental re-

search in the social sciences. It is not that we have failed to keep up with Europe in demographic practice but that our practice has not been associated with educational institutions: that situation is changing.

E. B. WILSON

A POPULAR WORK ON VIRGINIA'S CAVERNS

WILLIAM M. MCGILL. **Caverns of Virginia.** xvi and 187 pp.: maps, diagrs., ills., bibliogr., index. *Virginia Geol. Survey Bull. 35, Educ. Ser. No. 1.* University, Virginia, 1933. $1.00. 11 x 8 inches.

As a popular presentation this handsome and well illustrated volume will undoubtedly meet with success. As an educational bulletin, however, one must regret that it does not show more originality of treatment and that its descriptions are not turned towards a truly scientific if elementary approach to interpretation of the phenomena with which it deals. The responsibilities of a state survey may well include the promotion of a scientific habit of thought, for the exercise of which the problem of cavern origins offers an excellent opportunity along relatively simple lines. The excuse that the author "has not had an opportunity to determine the application" to Virginia caverns of the two-cycle theory of cavern excavation published three years ago seems inadequate.

Under the heading "Origin of the Caverns" it is briefly asserted that "the caverns . . . have doubtless been formed chiefly during the last erosion cycle," that is the cycle, recently introduced by regional uplift, during which the Shenandoah River has incised its shallow, winding, and relatively narrow valley in the broad floor (now a low upland) of the great Appalachian Valley. The implication is that the caverns have been rapidly excavated and then partly replenished with dripstones during the short period in which the subterranean streams beneath the low uplands have been draining the cavernous limestone to the surface streams of the newly deepened valleys. Thus is arbitrarily set aside the possible excavation of the caverns by slow ground-water solution during the vastly longer periods of Great Valley degradation before the recent regional uplift, concerning which explicit statement, illustrated with a good figure, is made on an earlier page. Moreover, nothing is said in this connection of the simple explanation that this slow two-cycle process of cavern excavation provides for the striking change from an earlier period of solutional excavation while the caverns were water-filled to a later period of depositional replenishment after regional uplift required the water filling to be drained away. A good opportunity is here missed of introducing an elementary example of scientific method. This point may be illustrated as follows:

Maps of several developed caverns show that their passages are often looped with underfoot or overhead crossings. In connection with these striking features the question might be asked: Are these loops and crossings more consistent with the excavation of the caverns by the active erosional and solutional work of underground streams, whose courses should be arranged in branching fashion, or with their excavation by the much slower process of ground-water solution, which might easily produce a tangled, three-dimensional maze of passages? It is not to be expected, of course, that untrained visitors to caverns will formulate such a question; but the question would surely excite interest among the more intelligent visitors, who would thus be gently introduced to the scientific method of approaching an unsettled problem.

Other topics that might be treated in elementary scientific form are the gradients of cavern passages, roof etchings, and floor clays. Space for these added topics might be easily gained by compression elsewhere—in the conventional descriptions of the dripstones, for instance. The text not infrequently includes such technical terms as calcium carbonate, aragonite, helictites, Paleozoic, pre-Cambrian crystalline rocks, great thrust faults, anticline, peneplain, monadnock, erosion cycles, adjustments

in stream courses—all of which must be wholly unfamiliar to the vast majority of cavern visitors. Hence it does not seem that the question of the preceding paragraph or similar questions regarding etched roofs or floor clays should be regarded as unduly advanced.

W. M. DAVIS

THE EXPLORATION OF THE WESTERN UNITED STATES

E. W. GILBERT. **The Exploration of Western America, 1800–1850: An Historical Geography.** xv and 233 pp.; maps, ills., bibliogr., index. University Press, Cambridge; The Macmillan Co., New York, 1933. $3.25. 9 x 6 inches.

Mr. Gilbert discusses the history of exploration in the United States west of the Mississippi, 1800–1850. His book is well documented, well balanced, and equipped with bibliographies and clear outline maps. The first part, which fills nearly half of the volume, is a geographical analysis of western America. On the basis of the writings of modern authorities (Fenneman, Bowman, Ward, Livingston and Shreve, Wissler, and others) an outline is given of the main facts of physical geography, climate, natural drainage, natural vegetation, animal life, and Indian life. Striking passages quoted from the works of the early explorers enliven the more formal descriptions. In the second part an attempt is made "not only to describe the history of the discovery of the geographical facts . . . analysed in Part I, but also to show how those facts influenced the order of events."

A great deal has been written on the history of exploration. Many a work on the subject is hardly more than a compilation in which appears a succession of brief, dry summaries of routes traversed. Some writers, with an eye to the general reader, have made selections of adventurous or sensational incidents. Others have dealt with exploration as a phase of wider political, social, or economic movements, but usually with little understanding of the geographical problems involved. Relatively few have, as Gilbert has done, conceived of exploration as a geographical phenomenon in itself, worthy of interpretation in the light of all phases of modern geographical knowledge of the regions explored. Gilbert shows that the progress of exploration is closely dependent upon the facts of the natural environment; that, while the critical scholar may fairly question many of the claims that have been made for geographical "influences" on things that men do, there is no doubt about the influence of river valleys, deserts, and snow-choked mountain fastnesses in determining the routes taken by explorers and their experiences in following these routes.

Whether or not we agree that the discovery of South Pass in Wyoming about 1823 "was one of the most important events in American history," it was certainly an important event in the exploration and settlement of the Far West. Gilbert's analysis in Part I makes it easy to understand the strategic position of this pass, "situated at the head of the waters of some of the greatest rivers of the continent"—North Platte, Snake, Big Horn, and Green—and offering an easy, open, and relatively low passage from the Great Plains into the Great Basin, between the more difficult forested Rockies of northern Wyoming and Montana on the north and of Colorado on the south.

Mr. Gilbert is lecturer in geography at the University of Reading, England, and his point of view is British. Nearly every American schoolboy is familiar with the Lewis and Clark expedition (with which Part II begins), but its importance and magnitude have been less widely recognized in Great Britain. Almost with a note of surprise, Gilbert states what Americans have long regarded as obvious: "There is no doubt that they [Lewis and Clark] deserve a place beside the great explorers of the world, and may justly be compared with Livingstone and Stanley in Africa and with Hedin and Stein in central Asia." In his conclusion Gilbert remarks: "The exploration of Africa, of Asia, and of Australia have often been described and

the explorers of these continents are well known. The exploration of America during this period has been frequently neglected in general works on exploration." Yet how many Americans know anything about the exploration of Australia?

The Geographical Factor in American History

Ellen Churchill Semple. **American History and Its Geographic Conditions.** Revised in collaboration with the author by Clarence Fielden Jones. x and 541 pp.; maps, bibliogrs., index. Houghton Mifflin Company, Boston, 1933. $3.00. 7½ x 5¾ inches.

Clarence Fielden Jones. **Manual to Accompany American History and Its Geographic Conditions.** viii and 39 pp.; 46 maps and diagrs. Houghton Mifflin Company, Boston, 1933. $1.15. 11 x 9 inches.

In the new edition of the late Miss Semple's well known book "the authors have retained the original organization and method of treatment of the text." For the sake of clarity and to bring the volume up to date, many changes have been made in points of detail, new maps have been introduced, and supplementary reading lists added. The reading lists are an excellent feature. Besides references to scholarly works, selected titles are given of "literary readings"—fiction, books of travel, histories, and poems.

Suggestive and scholarly as the volume is, one "geographic condition" of American history receives, nevertheless, too little attention, namely sectionalism. The concept of the section as a factor of importance in the development of the nation had not been clearly pointed out by Professor F. J. Turner at the time the first edition appeared. It is disappointing, however, to find no adequate discussion of sectionalism in the revision, nor any reference in either the bibliographies or the footnotes to Turner's brilliant studies of the subject. Lines of sectional cleavage are deeply rooted in geographical circumstances. Recognition of sections and subsections provides a link between geography on the one hand and, on the other, some of the vital questions, such as those of tariff and currency, that have arisen in the political and economic history of the nation—questions barely noticed, if noticed at all, in Miss Semple's volume.

The book reflects the optimism of the early 1900's. "Main Street," "Babbitt," "Winesburg, Ohio," "Middletown," and "An American Tragedy" find no place among the novels and literary works listed, nor did the authors in their revision see fit to change this observation: "Everywhere one notices a certain largeness of view in the ordinary Westerner. Even when uncultured and crude from lack of opportunity, he *never* takes a contracted view of things. . . . He is *never* provincial. . . . " The italics are ours.

Professor Jones's manual should prove very useful to teachers. It includes exercises and questions based on the text, together with 46 maps and graphs "prepared especially to supplement the materials of the text" and designed for coloring by the students.

Handbook of South American Geography

Otto Maull, Franz Kühn, Karl Troll, and Walter Knoche. **Süd-Amerika in Natur, Kultur und Wirtschaft.** In 16 parts: 518 pp.; maps, diagrs., ills., bibliogrs., index. (Handbuch der Geographischen Wissenschaft, Lfrgn. 3, 4, 6, 8, 11, 18–21, 25, 27, 29, 46, 48, 50, 51.) Akademische Verlagsgesellschaft Athenaion m. b. H., Wildpark-Potsdam, [1930–1932?]. 12 x 9 inches.

Four men well known for their exploration work in South America and for their writings on the geography and geology of various parts of the continent have contributed the articles that make up the South American section of the "Handbuch der

Geographischen Wissenschaft." The introductory article on South America as a whole and the article on Brazil are by Otto Maull. The articles on the Argentine Republic, Uruguay, Paraguay, and the Falkland Islands are by Franz Kühn, who was for a number of years professor of geography at the National University of the Litoral at Paraná and whose knowledge of much of the area covered by his articles was gained at first hand on the many expeditions in which he has taken part in recent years. Walter Knoche, who contributed the article on Chile, is a professor at the University of Santiago and a prolific writer on the geography and meteorology of Chile. Karl Troll, who has in the past few years carried out extensive explorations in the Andean countries, contributed the articles on Bolivia, Peru, Ecuador, Colombia, Venezuela, the Guianas, and the island dependencies of Curaçao and Trinidad and Tobago.

One is naturally inclined to compare this section of the Handbuch with Pierre Denis' two volumes on South America in the "Géographie Universelle." The approach and treatment are quite different. Denis also treated his subject in part country by country, but his eye was always on the natural region—physical or economic—and his product is regional geography of the first order. The South American section of the Handbuch is in no sense regional geography. It can best be described as a general survey of the leading geographical features and relationships of the various countries with an introductory article on the continent as a whole. It cannot be said that the series of articles taken together presents much that is new either in facts or in original analyses and syntheses.

Otto Maull's introductory article is a good model for a brief geographical description of a continent. In 64 pages of text, illustrated by many happily chosen photographs and numerous distributional maps, he has presented against a broadly generalized background of physiographic history the features and relationships of topography, climate, natural vegetation, and human occupation essential to a picture of the continent as a whole. Moreover, in spite of the fact that in order to encompass so broad a picture in such a small space he has had to strip it of all but the barest essentials, he has succeeded in producing an exceedingly interesting and readable article. This is, in fact, an outstanding characteristic of all of the articles in this section of the Handbuch. They are articles that the layman can read with interest; yet, if they have been prepared with a view to popular consumption, their authors have made only one concession to popular appeal. The tables of statistics that usually play a large part in articles of this type have been mostly replaced by distributional maps, while, for those who want precise figures, various tables giving population densities, urban populations, production statistics, etc., are furnished in an appendix to the whole section.

The similarity in the types of photographs and distributional maps used to illustrate the articles and their uniform excellence give the impression that all the authors have followed the same pattern in preparing their articles; but this is the case only to a limited degree. In all the articles geomorphology is emphasized in the physiographic descriptions, historical backgrounds are treated alike, and natural vegetation plays an important part in descriptions of landscapes. Only in Kühn's articles, however, is any considerable space given to economic geography. Kühn discusses products in their relations to the world market; elsewhere they are discussed only as part of man's activities in developing the natural resources of his environment. Little space is given in any of the articles to political geography. Maull, Kühn, and Knoche close their articles with hopeful prophecies for the future, whereas Troll presents only the geographical features and factors as he sees them and draws no conclusions and makes no prophecies.

The photographs with which all the articles are profusely illustrated are unusually well chosen, but the color reproductions of landscape paintings must be rated as failures. In no case do they truly represent the colors of the landscape, and in most

cases they give a completely erroneous picture. The distributional maps are as a rule original in concept and excellent examples of the sort of generalization necessary if a small-scale distributional map is to present clearly the facts it is intended to show. An insert map of the whole continent on the scale of 1 : 16,000,000 is a fine piece of engraving and remarkably detailed for a map on so small a scale. It is to be regretted, however, that more care was not taken in bringing the international boundaries up to date. While, in the Peru-Ecuador-Colombia boundary zone, the present boundary between Colombia and Peru is shown more or less correctly, no indication is given of the Colombia-Ecuador boundary established by treaty in 1916, which now forms the southern limit of the strip of territory south of the Putumayo River assigned to Peru by the Peru-Colombia treaty of 1922 to which Ecuador makes no claim. Instead, Ecuadorean and Peruvian territory is divided by a broken line that follows a course new to cartographers and unjustified by the claims of either country, since it indicates as claimed by Ecuador territory north of the Colombia-Ecuador boundary of 1916.

A South African Rainfall Study

F. E. Plummer. **Aspects of Rainfall in the Western Cape Province: A Basis for Geographical and Agricultural Study.** xi and 80 pp.; maps, diagrs., bibliogr. (Univ. of Pretoria, Ser. No. I, 22.) [Pretoria], 1932. 10 x 7 inches.

Plummer has already written of "Rainfall and Farming in the Transvaal" (compare *Geogr. Rev.*, Vol. 18, 1928, pp. 154–155). The paper now under review deals with the Western Cape Province. When like studies have been completed for the rest of the country, "a more comprehensive summary will be made of the Union's rainfall in relation to farming."

The paper contains a number of interesting maps on the scale of 1 : 6,000,000—one reduced from the relief map, 1 : 1,000,000, now being prepared by the Geological Survey. The annual-rainfall map "after Lewis" is not clearly reproduced, has apparently no added data, and omits the 15, 25, and 35-inch isohyetals of Lewis's admirable map on the scale of 1 : 2,500,000 in "Rainfall Normals up to the End of 1925" (see *Geogr. Rev.*, Vol. 18, 1928, p. 176).

The other maps, all excellently clear, include one of the average annual number of rainy days, four of the mean rainfall in inches for the seasons of the year and another four in percentages of the annual mean, one of "average monthly periods each with more than 9% of mean annual rainfall," and one of the "average annual rainfall likely to be received 75 years per century." Professor Plummer regards this as very important. Probably the "century" would not be insisted on, as most of the observations are for less than 30 years. He has been computing 75 per cent of the total time; 21 years out of 28 would be better.

The South African farmer is advised to plan his operations for distinctly less than the average annual rainfall, for only in certain favored districts "is the percentage variability of the rainfall from year to year sufficiently low to enable use being made of the average annual amount of precipitation as a criterion for planning agricultural operations without serious risk of a too frequent recurrence of years with such deficient supplies of atmospheric moisture that the crops may not arrive at full maturity." "Owing to the erratic character of the rainfall some value appreciably lower than the average rainfall should be taken as a guide." "The numerical results and the conclusions . . . are considered approximations to the truth, such as are justifiable in the circumstances. They are put forward in the hope . . . that they will assist farmers and others in making better use than heretofore of the country's moisture supply" and as an incentive to making better meteorological observations.

Most of the paper is a detailed description of the rainfall régime in 23 divisions of the country, with occasional explanations.

Of interest is the comparison of the rainfall of London with that of Cape Town for the 88 years 1838 to 1925 inclusive. They happen to have about the same annual average—London, 24.55; Cape Town, 25.19 inches. The minimum during 75 per cent of the period at London was 21.95, at Cape Town, 21.24; the absolute minimum at London, 13.11, at Cape Town, 17.48; the absolute maximum at London, 37.18, at Cape Town, 41.02; the maximum above average at London, 12.63, at Cape Town, 15.83; the minimum below average at London, 11.44, at Cape Town, 7.71. Thus London appears more liable to drought, as far as absolute rainfall figures alone indicate anything, and Cape Town more liable to flood!

MARK JEFFERSON

THREE DISTINCTIVE EUROPEAN ATLASES

GEORG WOLFRAM AND WERNER GLEY, edits. **Elsass-Lothringischer Atlas: Landeskunde, Geschichte, Kultur und Wirtschaft Elsass-Lothringens.** 45 plates; accompanying explanatory text, viii and 167 pp. (Veröffentlichungen des Wissenschaftlichen Instituts der Elsass-Lothringer im Reich an der Universität Frankfurt.) Selbstverlag des Elsass-Lothringen-Instituts, Frankfurt am Main, 1931. RM. 22.50. 16 x 11½ inches; text 10 x 7½ inches.

Landesplanung im engeren mitteldeutschen Industriebezirk: ihre Grundlagen, Aufgaben und Ergebnisse, arranged and edited by the Landesplanung Merseburg and various collaborators. 39 plates. Verlag der Landesplanung für den engeren mitteldeutschen Industriebezirk, Merseburg, 1932. RM. 30. 24 x 19 inches.

Atlante internazionale del Touring Club Italiano. 4th edit., xvi pp.; 176 pp. of maps; 231 pp. of index. Edited and published under the direction of L. V. Bertarelli, O. Marinelli, and P. Corbellini by the Touring Club of Italy, Milan, 1933. L. 400. 19½ x 13 inches.

The editors of the atlas of Alsace-Lorraine state that by using the dispassionate medium of maps they have eliminated the bias so easily introduced into verbal presentations of facts. Of course, every geographer knows that cartographical representation *per se* does not exclude bias, and one might be excused for suspecting that an atlas of the former Reichsland would be a vehicle of propaganda, especially when produced by an all-German staff of contributors. Such, however, does not seem to be the case in this instance, and the editors' claim to scientific impartiality appears valid.

Forty-five plates, on which are printed more than 115 maps, illustrate a wide range of subjects. The atlas begins with the natural setting—physical geography, climate, and vegetation. Instead of a stereotyped geological map differentiating rocks by age, a geomorphological map is introduced, with colors and symbols indicating areas having similar land forms. The historical section opens with maps on which are plotted the locations of prehistoric, Roman, Alemannic, and Frankish sites. There is a map of forested, swampy, and settled areas about 500 A.D., followed by series covering church history, art, and political boundaries and territorial questions to 1918. The distribution of languages is mapped for 1910 by cantons and for 1905 by an adaptation of the dot method developed by A. Penck and H. Heyde for eastern Germany and a part of Poland. Some of the maps of dialectic boundaries are highly ingenious. Five maps are devoted to population, one showing densities in 1910, the others increases and decreases by cantons between 1871 and 1921. Village types and the growth of cities are illustrated in a special subdivision, and the volume closes with industries, agriculture, and commerce. The purpose of the accompanying text is "briefly to make clear the scientific significance of the contents of the maps, to point out certain interesting details, and to justify the various methods of graphic representation."

From a technical point of view, even more remarkable is the second publication listed. As a background for a regional plan of the "Central German industrial region proper" (the region about Leipzig, Halle, and Magdeburg), surveys were made of central Germany as a whole. The results are laid down on an introductory series of 18 maps (1 : 1,000,000), which can hardly fail to bring delight to every geographer who examines them. As Professor Schlüter suggests, many a geographer has dreamed of making maps of this sort but has been without the means of doing so (Otto Schlüter: Über ein neues Kartenwerk zur Kulturgeographie, *Geogr. Anzeiger*, Vol. 33, 1932, pp. 340–345). The area covered centers on Leipzig, extending northwest to include Hanover, north and northeast beyond Berlin and Frankfort-on-the-Oder, southeast to the Czechoslovak frontier, and southwest into Franconia. Many of the essentials of physical and human geography are depicted—topography, climate, drainage, water supply, forests, agricultural regions, population densities and trends, mineral resources, economic structure and changes, lines of communication, railroad traffic volume for both freight and passengers, and highway traffic.

The introductory series is followed by six maps (1 : 200,000) of the "Central German industrial region proper" and by 15 "economic plans" (1 : 25,000 and 1 : 50,000) of local districts. Most distinctive of all is Plate 19, showing the distribution of mining and manufacturing establishments. Each plant employing ten or more persons is represented by a disk. The diameters of the disks are proportional to the number of employees, and their colors vary according to the type of the industry. The effect is unconventional but extremely striking. The clusters of disks around the industrial centers look something like masses of caviar, except that the "eggs" are of different sizes and of many brightly varied hues. Another map shows the daily volume of commuters' traffic between residential areas and places of work. Two maps are devoted to the regional plan itself, one showing existing and proposed lines of communication, the other proposed areas to be set aside for manufacturing, residential, and recreational uses (see also Irmfried Siedentop: Landeskundliche Auswertung des Kartenwerkes der Landesplanung Merseburg, *Mitt. des Sächsisch-Thüringischen Vereins für Erdkunde zu Halle a. S.*, Vol. 55–56, 1931–1932, pp. 29–53).

The third edition of the Italian Touring Club's superb atlas (1929) has been reviewed in these columns (*Geogr. Rev.*, Vol. 22, 1932, pp. 174–175). The fourth edition contains nine new inset maps of cities and twelve entirely new plates—one of Albania, one of the Polar Regions incorporating the results of recent explorations, and ten of Italy on a larger scale than that of the earlier editions (1 : 1,250,000 instead of 1 : 1,500,000). In addition, many improvements have been made on the old plates; for example, those necessitated by the rewriting of Turkish place names according to the newly adopted official scheme of Latin orthography, by the introduction of new place names in Greece owing to the transfer of populations, by alterations in boundaries, etc. In consequence, no less than 60,000 changes and additions have been entered in the index. Periodical revision at frequent intervals is thus keeping the atlas up to date. Plates of the atlas may now be purchased separately.

A New Linguistic Map of Europe

M. Wehrli. **Neue Völker- und Sprachenkarte von Europa,** 1 : 10,000,000. Geograph. Anstalt Kümmerly & Frey, Bern, [1932?].

This is an unusually clear linguistic map, covering not only Europe but northern Africa and southwestern Asia as far east as the Persian Gulf. One hundred and five tints of color and symbols are employed, including 13 for Germanic, 17 for Romance, 16 for Finno-Ugric, and 12 for Altaic tongues. Paul Langhans, on his well known map (1 : 10,000,000) of the languages and religions of Europe (*Petermanns Mitt.*, Vol. 63, 1917, Plate 1), differentiates only 36 tongues but shows in addition the boundaries of various regions in which the use of different alphabets, legal systems,

house forms, and calendars prevails. Arthur Haberlandt's great wall map, "Karte der Völker Europas" (1 : 3,000,000), published in 1927 by Freytag and Berndt of Vienna, shows 45 languages, for each of which gradations of tinting suggest six densities of population.

On Wehrli's map coast lines, drainage, and place names are lightly printed in brown. On this base are superimposed the colors representing the languages and, in black, political boundaries and names of peoples. The general effect is pleasing, and the critical relationships between political and linguistic frontiers stand out sharply.

Many small linguistic areas usually overlooked on other similar maps are indicated. These lie not only in the regions of notoriously fragmented peoples and tongues—the Balkans, east-central Europe, the Caucasus, northeastern Russia—but in other regions as well. For example, the outlines are carefully drawn of French and Italian colonies along the northern shores of Algeria and Tunis, of the Zakonian dialect of modern Greek in the eastern Peloponnesus, of Yiddish settlements in Palestine. This close attention to detail gives the map its outstanding quality. Isolated patches of alien speech in unexpected places tempt the reader to investigate their origin and character. One is struck, for instance, by the scattered colonies of Greeks and Albanians in southern Italy and Sicily and by a Serbian settlement in the foothills of the Apennines just west of the "spur" of the Italian peninsula. These folk from the Balkans came into Italy as refugees from the Turks during the Middle Ages and have lingered, preserving not only their speech but many of their customs and distinctive costumes (Teobaldo Fischer: La penisola italiana, Turin, 1902, pp. 374–375). Today the majority are ignorant peasants and mountaineers, although an exception is found in Palermo, where certain of the Albanians are people of cultivation and distinction (A. M. Annoni: Stranieri e lingue straniere in Italia, *Boll. Reale Soc. Geogr. Italiana*, Ser. 5, Vol. 10, 1921, pp. 5–18; reference on p. 9).

Wehrli makes no attempt to combine different symbols in such a way as to differentiate regions where two languages are spoken by approximately the same number of people. Indeed, certain parts of Scotland and particularly of Ireland where he places the symbol for Gaelic have in reality a Gaelic-speaking population of less than 50 per cent or even of less than 30 per cent of the total (compare maps in A. Demangeon: Les Iles Britanniques (Géographie Universelle, Vol. 1), Paris, 1927, pp. 105 and 126; for additional references to studies of the linguistic geography of Europe see *Geogr. Rev.*, Vol. 21, 1931, pp. 500–501).

Historical Geography of Australasia

J. Holland Rose, A. P. Newton, and E. A. Benians, edits. **The Cambridge History of the British Empire, Vol. 7.** Part 1, **Australia,** xix and 759 pp.; bibliogr., index. Part 2, **New Zealand,** xiii and 309 pp.; bibliogr., index. The Macmillan Co., New York; University Press, Cambridge, England, 1933. Part 1, $7.00; Part 2, $3.50. 9½ x 6½ inches.

For several reasons Volume 7 of "The Cambridge History of the British Empire" will interest the American student of historical geography. It is likely to stand for some time as the most comprehensive and authentic account of the discovery, exploration, settlement, and economic exploitation of Australasia. The three well known editors have been assisted by Professor Ernest Scott and Dr. J. Hight as Australian and New Zealand advisers respectively, and most of the twenty-nine contributors have published a considerable amount of Australasian research work. The approach to the majority of chapters is strongly geographical. The history of the interaction between the environment and the incoming white settlers, together with the political, social, economic, and cultural progress in both countries, offers important parallels and contrasts with similar processes in the United States.

The two parts of the volume naturally differ in size and arrangement. The most striking contrast is the relative space and attention allotted to the aboriginal peoples. No less than four out of thirteen sections in Part 2 are devoted to the Maoris, a high-grade people: Part 1 does not devote a single section to the unfortunate primitive peoples of Australia and Tasmania—a fact in striking accordance with much of Australian history and with the amount of financial assistance and interest bestowed in many parts of the commonwealth upon the survivors of the race.

The importance of environment is emphasized throughout the history of both countries. Sociologists who strive to minimize the importance of environmental factors might well examine the evolution of white civilization in these virgin regions where the operation of natural forces has not yet been greatly obscured by the work of man. Throughout the span of Australasian history—from the dawn, when trade winds and cold drove the Latin voyagers too far northwards, to modern time, when isolation has protected and fostered remarkable social and economic experiments—the weight of these environmental influences has been preponderantly great. Dr. J. Holland Rose, Dr. J. A. Williamson, and Dr. J. R. Elder, who write on Pacific Ocean discovery and exploration; Professor Ernest Scott, on inland exploration and settlement in Australia; Mr. E. A. Benians, on the development of the western Pacific; Professor E. O. G. Shann, on economic and political progress in Australia; Dr. A. J. Harrop, on the New Zealand Company colonization and the work of New Zealand in the Empire; and Dr. J. Macmillan Brown, in a delightful epilogue on New Zealand, are only some of the contributors who express this trend.

Most important to research students is the inclusion in the volumes of more than one hundred pages of bibliographical matter, which contains among other things a very valuable account of the location of the chief sources of manuscript material in Great Britain, France, New Zealand, in the Commonwealth Federal Capital, and in the Australian states. Time will no doubt disclose many collections of papers to supplement the present bibliography. One thinks immediately of Spanish and Dutch archives for records of the early voyages and of the whaling logs preserved in the eastern United States. It is good to learn of the progress of the young dominions in this respect. New Zealand has founded an archives department, and, while the Australian Commonwealth has not yet recovered from the shock of moving its papers from Melbourne to Canberra, the Commonwealth Library has begun to acquire some priceless documents, such as papers of Cook and Banks. The archives of the Australian states are in various stages of evolution—from South Australia, where an excellently organized department is collecting private and governmental records, to Queensland, which has done nothing whatever as yet.

Perhaps most interesting to Americans will be the comparisons and contrasts noted by these volumes between the Australasian countries and the United States. In a delightful essay John Buchan once outlined the importance of the casual and the causal in history. It was possibly the casual that provided the coral rock that plugged the gash in the *Endeavour* and saved Cook and Banks to open the way for the foundation of a British Australia, but it was clearly the causal that created the colony of New South Wales when independent America diverted the stream of British convicts from what is now the United States. Professor Scott, creator of the Australian historical school and trainer of the leading Australian historians, leaves no doubt on this question. "Australia was the child of the American Revolution, and was cradled during its sequels, the French Revolution and the Napoleonic wars. Without the American Revolution there certainly would have been no settlement in 1788." But Professor Scott is equally certain that Britain founded the future commonwealth not for American loyalists but for those whom George Barrington described as—

> "True patriots all; for be it understood
> We left our country for our country's good."

Relations between the United States and Australasia find frequent mention. American whalers and sealers were early in Australasian waters, not always to the delight of British administrators, who used their presence—quite unfairly—as an argument for the establishment of "holding stations" in remote parts of the continent. The penetration of the great republic to the Pacific and the gold discoveries that heralded those "rushes" that "precipitated a colony [Australia] into a nation" profoundly influenced the Australian outlook and life. Nor was New Zealand unaffected. On several occasions a section of the island people made strong demands that their country should secede from the British Empire and seek annexation to the United States.

The closing chapters of the two volumes emphasize the similarities and contrasts in the progress of the two young Pacific democracies, and here again environmental influences take a leading place. In many respects insular surroundings are affecting the New Zealanders, while continental ones are placing their mark on Australians. The vast size of the Australian political divisions, for example, are creating, as in Canada, grave governmental difficulties, which express themselves in endless wrangles between the federal government and the states. Even in culture Australians are showing the effects of their strange new-old continent. In the words of the late Sir Archibald Strong, who contributed the chapter on Australian culture: "Not only with poetry but with the other arts as well, change of soil and scene must be set off against identity of speech, or of other medium; and perhaps the gum tree, that haggard but exquisite symbol of Australian nationhood, must share the responsibility if Australia deserts an old and honoured tradition in the endeavour to create a new and more individual one." Strong, who knew well and deeply loved his native country, could penetrate through the crudeness of a young and almost frontier civilization to see that the augury for the future spiritual progress of Australia lies in the energy and imagination of the many finer spirits among her youth.

New Zealand, by climate, by insular and mountainous character, and by tradition, is rather different. Though even more remote and isolated than Australia, she was founded for free settlers, who have produced in a not un-English environment a remarkable parental resemblance that shows itself in a "conservatism in sentiment" and in a "civilisation formed on the pattern of English life." Thus, while the young dominion is progressing through national childhood on much the same lines as her continental neighbor and has already stood beside her for the Empire on many a battlefield, she has steadfastly refused to join the Australian federation or to subordinate her individual life.

A. GRENFELL PRICE

THE PEOPLE OF TRISTAN DA CUNHA

DOUGLAS M. GANE. **Tristan da Cunha: An Empire Outpost and Its Keepers, with Glimpses of Its Past and Consideration of the Future.** 173 pp.; ills., bibliogr. George Allen & Unwin, Ltd., London, 1932. 7s. 6d. 8 x 5¼ inches.

One of the most isolated British communities anywhere on earth is a little settlement of some one hundred and sixty souls on the bleak volcanic island of Tristan da Cunha, in the South Atlantic halfway between Cape Town and Buenos Aires. There is no regular communication between these people and the outside world. Months, even years, pass by without the appearance of a ship off the open beach above which their low thatched cottages stand. For some time before the Boer War the British Admiralty sent a warship at regular intervals, but this practice has been discontinued, and today the islanders must rely on such vessels as casually come their way. Thrown largely on their own material and spiritual resources, they have developed physiques, outlooks, and ways of living that are distinctive and deserve more intensive study than has yet been given them.

The settlement was established in 1817. Purely British at first, there has been

some admixture of foreign blood—from America, Holland, Italy, Denmark, the Cape, and St. Helena—derived in good part from persons who have been shipwrecked and have chosen or been obliged to remain. Perhaps this helps account for the absence of the degeneracy that one might expect in such a small group where intermarriage is frequent. The settlers are healthy and long-lived, and the common contagious diseases of childhood are unknown. Diet is extremely simple, mainly of potatoes and fish. Formerly grain was cultivated, but this has become impracticable owing to the destruction of the crops by an endemic plague of rats that came ashore from a vessel wrecked in 1882.

The people, although naturally intelligent, are ignorant, for they have had the benefit of outside assistance in educating their children only during the relatively short periods when English missionaries have resided among them. The standard of morality is high. Mr. Gane attributes this to "the social purification that operates amidst small communities left to themselves" and cites Pitcairn Island in the Pacific as a similar example. The settlers on Pitcairn Island are descended from the mutineers of the *Bounty*, among whom were hard-drinking, murderous characters. "Yet, in the course of one generation" this community "became, in the words of Admiral Moresby, 'a people raised to a state of the highest moral conduct and feeling.' "

Tristan da Cunha gets along with a minimum of government. It would seem to approach the anarchist's ideal, in which the people live on terms of peace and good understanding with one another and there is no need for rules and regulations. Some documents dating from the early period of the settlement have recently come to light in New London, Conn., where the sons of the founder made their home. These documents include articles of agreement entered into by the settlers in 1821—a sort of constitution in which the guiding motive is "to preserve individual liberty, with a minimum of any sort of governmental control, and to retain, or reserve, to themselves such control of their affairs as seemed to them best for the common good" (D. M. Gane: Early Records of Tristan da Cunha: The Discovery in New London, *United Empire*, Vol. 24, 1933, pp. 589–598, 651–658, and to be concluded). Recently two missionaries "organized the heads of families into a rudimentary 'House of Parliament,' " hoping, "in this manner, to instil an additional sense of responsibility, and to settle matters of general interest to the community" (E. K. Grayson: Tristan da Cunha, *Canadian Geogr. Journ.*, Vol. 1, 1930, pp. 707–714; reference on p. 709).

Mr. Gane, honorary secretary of a fund established in England for the benefit of the islanders, has brought together from books and other sources much of interest concerning the history and inhabitants of the island. First-hand accounts of sojourns there have been published in book form by the wives of two of the missionaries (K. M. Barrow: Three Years in Tristan da Cunha, London, 1910; R. A. Rogers: The Lonely Island, London, 1926), and data on the people, topography, and natural history of Tristan and its neighboring islands will be found in Commander Frank Wild's "Shackleton's Last Voyage: The Story of the *Quest*," London and New York, 1923 (see *Geogr. Rev.*, Vol. 14, 1924, pp. 484–485).

A Monograph on the Kerguelen Archipelago

Edgar Aubert de la Rüe. **Étude géologique et géographique de l'archipel de Kerguelen.** Maps, diagrs., ills., bibliogr. *Rev. de Géogr. Physique et de Géol. Dynamique*, Vol. 5, 1932, pp. 1–231. Also published separately, Paris, 1932.

M. Aubert de la Rüe has written an excellent account of the Kerguelen Archipelago and one that will long remain the standard source of information on this desolate and inhospitable land. After an introduction detailing the inception and incidents of his expeditions of 1928–1929 and 1931 the author provides an excellent bibliography and a discussion of the cartography of Kerguelen. Then follow a

geographic study and a history of discovery and exploration. Notwithstanding the obstacles offered by difficult terrain of high relief covered with large ice sheets and glaciers, by limited equipment, an atrocious climate, and even by dangerous packs of wild dogs, M. Aubert de la Rüe has made very notable additions to the geographical knowledge of this inhospitable region and has been able to fill in many gaps in the existing maps. Succeeding sections of the book deal with geology, petrology, mineral deposits, paleobotany, and climatology, with a concluding section on morphology, in which the coasts, hydrology, glaciology, and wind action are adequately described.

Kerguelen may be regarded as the counterpart of Iceland in the Indian Ocean. Like Iceland, it is built largely of basaltic lava with subordinate trachytes and rhyolites and is situated on a submarine ridge connecting it with a continent. The author distinguishes four phases in the geological history of Kerguelen. The earliest series of basic lavas of "spilitic" composition, so far found only as glacial erratics, he assigns to the Mesozoic, and perhaps to even an earlier epoch. The reviewer finds it difficult to accept this conclusion, which is based on the great alteration the rocks are said to show. The second phase was characterized by eruptions of trachytic and phonolitic volcanoes that are believed to be of Eocene date. Then came a very extensive basaltic series due to fissure and Strombolian types of eruption, and a fossil flora of probably Oligocene age has been found in fluviatile strata interbedded with the lavas. This flora contains *Araucaria*, which indicates a much warmer climate during the Tertiary than now obtains in Kerguelen. The very advanced denudation of the archipelago and the fact that the present relief, in its main features, antedates the Pleistocene glaciation show that Kerguelen was subjected to prolonged weathering during the Miocene and Pliocene periods. Volcanic activity revived at the end of the Pliocene and persisted to the beginning of the Quaternary, and Mt. Ross, the largest volcano of Kerguelen, belongs to this fourth and final phase. The Pleistocene glaciation succeeded the volcanic period, and the ice then covered practically the whole island. The centers of glaciation were the main mountain massifs where ice sheets of astonishing magnitude still persist, nourished by the abundant precipitation and favored by the low temperatures, which combine to produce what must be one of the vilest climates on earth.

The biogeographic data are in favor of an old connection of Kerguelen with a continental mass, probably Antarctica. This was almost certainly by way of Heard Island, as the submarine ridge on which both islands are situated was shown by the *Discovery II* to extend far southward towards Queen Mary Land. M. Aubert de la Rüe adopts Wegener's view of continental drift as a working hypothesis to explain the separation of Kerguelen from Antarctica.

G. W. TYRRELL

THE PHYSICAL AND HUMAN GEOGRAPHY OF THE SEA

CAMILLE VALLAUX. **Géographie générale des mers.** vii and 796 pp.; maps, diagrs., ills., index. Librairie Félix Alcan, Paris, 1933. 10 x 6¼ inches.

This distinctive work is an attempt to encompass within the confines of a single volume both the physical and the human geography of that part of the earth's surface that is covered by the waters of the oceans and their dependent seas. After an introductory chapter, which reviews briefly the history of the exploration of the seas, the subject matter is presented in eight parts or books. Book I consists of two chapters dealing respectively with the domain of the seas and the cycles of the waters. Here we find the data with respect to the extent and depth of the seas, the classification into oceans and secondary seas, submarine topography, composition of sea water, evaporation in the sea, and the circuit of the waters from the atmosphere to the sea.

Books II to V are devoted to the oceans. Vallaux recognizes four oceans—Southern, Pacific, Indian, and Atlantic. The Arctic "Ocean" is classed with the secondary

seas not only because of its relatively much smaller extent and lesser depth but also because of its intracontinental character. In presenting the regional geography of the oceans, Vallaux follows the plan of beginning with the lesser known and proceeding to the better known. This brings out in illuminating fashion the growth and extent of human enterprise in the different oceans. Book II therefore begins with the Southern Ocean, to which are devoted five chapters, dealing respectively with the climate and waters of the surface, marine life, southern oceanic lands, the waters of the depths and the sea bottom, and man. In this last chapter there is an interesting discussion of whaling and sealing and of the effects of the opening of the Suez and Panama canals on the routes of navigation. These canals have dealt a serious blow to navigation in the Southern Ocean, and, as Vallaux puts it, "solitude is descending on previously frequented routes."

Book III deals with the Pacific Ocean, which the author divides into the Southern Sea, the Coral Sea, and the Northern Depression. In connection with the Southern Sea the problem of Easter Island is discussed and the latest data with regard to the Humboldt Current are given. In the chapter on the Coral Sea consideration is given to the coral-reef problem, and the various theories proposed are discussed briefly. In the chapter on the Northern Depression a section is devoted to the Kuro-sio and another to the Japanese and American fisheries. The final chapter of this book deals with the routes across the Pacific. This gives the author occasion to consider the questions of ancient migrations and connections between Asia and Australia and between Asia and America. These questions, Vallaux notes, give rise to problems "in which prehistory, anthropology, ethnography, and history are concerned. Geography, too, has its word to say, and perhaps it is its function to unify the data acquired by the others." The work of missionaries, traders, whalers, and pirates comes within the scope of this chapter, and the political partition of the archipelagoes and the routes from the Far East to America.

The Indian Ocean forms the subject matter of Book IV, dealing with the tropical waters of the south and the east, the coral plateaus and the monsoon sea, and navigation and routes in this ocean. From the earliest times the Indian Ocean has been the field of action of the most diverse peoples and the most varied marine techniques. Vallaux illustrates this by a consideration of the contrasting types of boats used in this ocean and the different peoples who used them.

The Atlantic Ocean, to which Book V is devoted, naturally receives more extended consideration than the other oceans. The regional geography is discussed in three chapters dealing respectively with the South Atlantic, the Equatorial Strait, and the North Atlantic. Separate chapters are then devoted to the Gulf Stream, the Arctic islands in the northern zone, and the routes in the Atlantic. In this last chapter we have a graphic recital of the gradual opening up of this intracontinental ocean to civilization. Here we find an account of the colonial era with its seamy accompaniment of filibusters, buccaneers, and slavers, of the transition from sail to steam and the consequent change in routes, of the contest for the blue ribbon—the race for the honor of the swiftest passage across the ocean. A final section deals with aerial routes. Because of its relative narrowness the Atlantic appears to lend itself readily to transoceanic flight. But, as the author notes, the rarity of islands except in the extreme north and the capriciousness of the weather in the latitudes between Europe and North America are serious difficulties. The construction of artificial islands in the sea as aids in transoceanic flight he regards as chimerical.

The secondary seas Vallaux groups into four classes—frozen seas, Far Eastern seas, mediterranean seas, and shallow seas. In the treatment of these he follows the same plan as in that of the oceans—proceeding from the lesser known to the better known. Book VI therefore deals with the frozen seas, one chapter being devoted to the Antarctic and the other to the Arctic. The humanization of these has thus far been small, so that the greater part of the matter deals with the oceanography, meteor-

ology, and marine life. In the chapter on the Arctic seas, however, consideration is given to the peoples living on the borders of these seas and to the polar flights. The other three classes of seas are treated in Book VII, one chapter discussing the Far Eastern seas, and another the shallow seas of the continental shelf of Europe. The remaining two chapters deal with mediterranean seas, one being devoted to those in the tropic regions and the other to the Mediterranean. In the latter a brief résumé is given of the conflicts of power that have taken place in that sea.

In Book VIII, the last one of the volume, the author considers the sea in its larger aspects—as an element of the cosmos, as the field of physicochemical changes, as a medium for plant and animal life, and as the scene of human activity. One chapter is devoted to each of these aspects, and they thus serve to synthesize the wealth of details discussed in the main body of the volume. The final chapter, dealing with the sea as the scene of human activity, is especially interesting. After a brief introduction on the influence of the sea in the history of humanity Vallaux discusses the sea as a source of food, the spirit of trade and adventure, the political domination of the narrow seas, nautical science and art, the partial industrialization of fishing, modern forms of commerce on the sea, the ship and its specialized types, the great ports, domination and freedom of the seas, and the human depopulation of the sea. As the author notes, to speak of the depopulation of the sea in view of the growth of activity on the sea is something of a paradox. But, as he goes on to explain, the increase in size and speed of ships has actually lessened the number of people and the time they spend on the sea. What in sailing ships was a voyage of a month or more is now but a trip of several days.

Any presentation of the physical and human geography of the sea on the scale attempted by Vallaux must necessarily draw on the data of a number of specialized sciences. To name but the more important of these in this connection, oceanography, marine biology, meteorology, and geology may be mentioned among the natural sciences, and anthropology, history, and economics among the social sciences. To focus on the sea the viewpoint of the geographer and to integrate under that viewpoint the data derived from the different sciences bearing on the problems of the sea obviously requires scholarship of a high order. Such scholarship Professor Vallaux brings to the task in this interesting volume.

H. A. MARMER

THE BOTTOM WATERS OF THE ATLANTIC OCEAN

GEORG WÜST. **Das Bodenwasser und die Gliederung der Atlantischen Tiefsee.** 107 pp.; maps, diagrs. (Wissenschaftliche Ergebnisse der Deutschen Atlantischen Expedition auf dem Forschungs- und Vermessungsschiff *Meteor* 1925–1927, Vol. 6, Part 1, No. 1.) Walter de Gruyter & Co., Berlin and Leipzig, 1933. 11½ x 9 inches.

The surface waters of the sea exhibit a well marked variation in temperature as related to latitude, from a little below 0° C. in the polar regions to about 27° in the tropics. The waters lying on the bottom of the sea, however, show practically no variation in temperature as related to latitude. Furthermore, the bottom temperatures are strikingly low, but little higher than 0° even in the tropical regions. The determination of the temperatures on the bottom of the different oceanic basins, the reasons for these strikingly low temperatures, and the causes that bring about the variations found thus constitute problems of major oceanographic interest. Moreover, the bottom temperatures aid in interpreting the relief of the sea bottom and the articulation of the oceanic basins.

In the first section the author reviews briefly the history of investigations on the bottom waters. This stratum of the oceanic waters was of interest not only in scientific investigations but also in connection with the laying of submarine tele-

graph cables. For no other layer of the sea, with the exception of the surface waters, is there so large a body of observational data. In the second section Dr. Wüst discusses these observations critically. Limiting himself to depths greater than 4000 meters, he considers the accuracy attained by the use of different methods and concludes that apparent discrepancies are in large part real differences arising from morphological features and oceanic circulation.

In an appendix to the second section the author lists the observational data on bottom temperatures and salinity for the Atlantic Ocean from those of the *Porcupine* in 1869 to those of the *Atlantis* in 1932. Not only actual temperatures are given, but also potential temperatures (the temperature that a particle of water at any given depth would acquire as a result of adiabatic cooling or expansion on being brought to the surface of the sea). Wüst illustrates the advantage of using potential temperatures by considering the temperature of the water at the bottom of a basin that ranges in depth between 4000 and 6000 meters and in which the temperatures as observed range between 1.0° C. and 1.25°. On reducing these to potential temperatures a value of 0.68° is derived, which shows that the bottom of this basin is filled with homogeneous water of uniform heat content, the variations noted being due solely to differences in pressure.

In the third section the author considers the horizontal distribution of temperature and salinity in the bottom waters. This is illustrated with three maps, showing, respectively, the potential temperatures, the actual temperatures, and the salinity of the Atlantic Ocean in depths over 4000 meters. The map of potential temperatures gives the clearest picture of the origin and distribution of the different bottom waters. In the great deeps of 4000 to 6000 meters it shows that the bottom waters exhibit relatively large temperature differences. The author calls attention to the fact that the conception of uniformity of conditions in the abyssal depths of the sea, which is still put forward at times, is not valid. And in no sense is the water in these depths motionless, for the current movements can be easily read from the isotherms. For the circulation of the bottom water of the Atlantic the South Polar basin is the most important source, the coldest bottom water being formed there. The last traces of this Antarctic water are recognizable from the distribution of bottom temperatures in approximately latitude 40° N., the Arctic bottom water playing only a small rôle.

The fourth section is devoted to the vertical structure of the bottom waters. In this section the author shows that in the thermo-haline structure of the bottom waters considerable differences exist that arise from differences in the development of the Antarctic bottom current and from the mixing of the waters of this current with the waters of the upper strata. The final section deals with the articulation of the Atlantic deep-sea bottom. Wüst directs attention to the fact that the horizontal and vertical distribution of temperature and salinity in the bottom waters of the Atlantic prove conclusively that this basin is more strongly articulated than had been taken for granted from the soundings alone. This distribution, furthermore, permits a more precise determination of the depths over the sills separating the different basins than is possible at present from the soundings. A sketch map showing the different basins of the Atlantic, which is appended to this section, gives the author an opportunity to raise the question of the terminology of the deep-sea bottom forms. Wüst follows Supan's geographic viewpoint in naming the larger features of oceanic relief. Instead of naming them after individuals or after ships, he employs geographic terms that designate the geographic positions of the particular features of submarine relief in question. Thus, instead of Tizard Deep we find the Brazilian Basin; instead of Valdivia Deep, the South Polar Basin. As to the advantage of this form of nomenclature there can be but little question. And, as the author notes, in the construction of charts showing the oceanic bottom relief due regard must be given the oceanographic considerations resulting from the study of the bottom waters.

H. A. MARMER

The Geography of Plants and Animals

Henri Gaussen. **Géographie des Plantes.** 222 pp.; maps, diagr., bibliogr. (Collection Armand Colin (Section de Géographie) No. 152.) Librairie Armand Colin, Paris, 1933. 10 fr. 50. 7 x 4½ inches.

Marcel Prenant. **Géographie des Animaux.** 199 pp.; maps, bibliogr. (Collection Armand Colin (Section de Géographie) No. 153.) Librairie Armand Colin, Paris, 1933. 10 fr. 50. 7 x 4½ inches.

Biogeography—the geography of plants and animals—is much more than mere description of the distribution of species. It involves the recognition of biological communities of widely varying sizes and types. It deals with the relations of such communities to one another and to their geographical environment; with the conditions and forces that bring about changes in the composition and structure of the communities as well as in the areas that they occupy and in their significance to mankind.

These small but extremely compact and thought-provoking books give an insight into the two branches of this complex and controversial science. Something of the philosophy of biogeography and critiques of its methods and objects are presented, rather than systematic expositions of data as in a textbook.

Gaussen's volume is divided into two parts. The first treats of "plants taken separately," or, more specifically, the geography of plants considered in terms of species, genera, families, and orders and the grouping of floras. The second, "Groups of Plants," has to do with the geography of types of vegetation considered in terms, not of individual species, but of composition and form. The study of such groups from the static and dynamic points of view and their designation, description, and classification are discussed at some length. The two concluding chapters deal with the vegetation of France and give a brief survey of the vegetation of the world. Gaussen maintains that, from the geographical point of view, the physiognomy of a given group or community of plants is more important than the actual species that the group comprises. Under similar environmental conditions in different continents quite different species may enter into the composition of—say moorland—formations that have, nevertheless, almost identical morphological characteristics. "The environment *imposes* the formation (or its derivatives); it *permits* a particular" combination of species. The dynamic study of groups is concerned in the main with changes brought about by the agency of man and has yielded results of great practical value to farmers and foresters. "Natural dynamism," on the other hand, is but little understood. Gaussen has scant respect for the minute investigation of small quadrats to which many phytosociologists "attach enormous importance." He observes with dry humor: "It seems reasonable to me that the precision of researches should be in proportion to the importance of the results to be obtained"—a remark not without geographical application. Exaggerated ingenuity in the development of technical terminology also draws his fire. Plant geography ought not to be allowed to become "an immense vocabulary—than which nothing is better calculated to sterilize a science. One should be able to find nature behind the vocabulary." A suggested systematic terminology of plant formations yields the word "Macrophanerophytium"; Gaussen adds, "I prefer 'forest.' "

Prenant's main theme is the dual nature of zoögeography, or the geography of animals—a distributional, or primarily statistical, aspect and an ecological aspect. His two opening chapters discuss the distribution of animals from the static and dynamic points of view—the areas occupied by different species and communities, the spread of species, centers of dispersion, various phases of zoögeographical history, etc. The more ecological approach is exemplified in chapters on animals in relation to natural environments, or *milieux*—adaptation, acclimatization, fundamental in-

fluences of light, heat, humidity, climates, and soils, and special adaptations to terrestrial, aquatic, biologic, and human milieux. Biogeographical laws, so far as such laws may be formulated at the present time, are essentially statistical—statements of probabilities rather than of certainties. For example, "it is *probable* that the area of a species with highly developed powers of dissemination will be vast; that the area of a stenotherm will be narrow; that in two analogous milieux the biologic types will be comparable; . . . that the introduction of a new predatory in a harmonic fauna will upset the latter; that an area occupied at hazard will be continuous," etc. Prenant holds that the greatest current need in biogeographical research is for a closer integration of the statistical with the ecological methods, today at best connected "very empirically."

Historical Geography of Plants

E. V. Wulff. **Introduction to the Historical Geography of Plants.** 356 pp.; maps, diagrs., ills., bibliogrs. (In Russian, with an English summary.) *Bull. of Applied Botany, of Genetics and Plant-Breeding, Suppl. 52*, Leningrad, 1932.

The vegetation of a region is subject to numerous agencies either facilitating or checking its development. They are responsible for gradual changes in the boundaries of botanical areas, for the supplanting of some species or groups by others, the elimination of some species and complete floras, and the development of new forms, individuals, and their societies. The history of the evolution of vegetation as a whole as well as of its individual representatives is inseparable from the general history of the evolution of the earth's surface. Knowledge of the causes reveals the origin of the contemporary distribution of plants. On the other hand, knowledge of the evolution of the existing relationships helps to discover the causes and in this way to read the past history of the earth. The interesting and fundamental volume by E. V. Wulff is devoted to this subject.

After a substantial review of the general problems involved and of the methods of investigation and a historical sketch the author discusses the determination of the areas, their origin, boundaries, and centers, and their classification. By an area (*area geographica*) he means a definite territory of the surface of the earth occupied by some systematic unit of plant or animal life.

A chapter is devoted almost entirely to a discussion and criticism of the age-and-area thesis of J. Willis, which is based on the theory of monotypic formation of species with gradual expansion of the area of distribution. The quite opposite views developed by D. Rosa are mentioned only in a footnote. His is the thesis that formation of species took place not at some particular points or "centers of formation" but over the entire territory of the original area. The more ancient forms of vegetation, being more primitive, were adapted to a wider range of natural conditions than the younger and more specialized species developed in the course of evolution.

In a discussion of the different forms of areas and their classification Wulff devotes special attention to discontinuous areas or "islands," of which he describes more than twenty principal types.

Analyzing the process of the geographical distribution of plants, Wulff, who supports a theory of monotypic formation of species, attacks the general question as to whether distribution "occurs gradually, step by step, occupying more and more territory until some impediment bars the spread or whether the dissemination of species can proceed in leaps through penetration of separate individuals into more or less distant localities isolated from the general area." His conclusion is that, in general, the distribution of plants is of a gradual character. Natural agencies, such as wind, currents of water, and birds, may be responsible for occasional but rather local dissemination of seeds and spores. However, no one of them is sufficient

for the explanation of the origin of many discontinuous areas. Especially is this true in regard to the areas separated by the seas and oceans. Explanation of the structure of many plant areas by factors now in operation is, therefore, not possible. The solution of the problem must be sought in the history of the continents themselves.

Wulff discusses the theories of "land bridges," of the permanence of continents and oceans, and of the polar origin of floras. The last, developed on the investigations of the fossil floras of the Arctic region by Heer, supposes the origin of the existing vegetation to be from a center around the North Pole, whence it spread southwards through Europe into Africa, through Asia and Melanesia into Australia—then a continuous land mass—and through North America into South America. Finally Wulff discusses Wegener's theory of continental drift, which, he considers, furnishes the most adaptable hypothesis so far advanced.

C. C. NIKIFOROFF

AGRICULTURAL MAPS AND THEIR USE

PAUL KRISCHE. **Landwirtschaftliche Karten als Unterlagen wirtschaftlicher und kulturgeschichtlicher Untersuchungen.** 112 pp.; maps, diagrs. Deutsche Verlagsgesellschaft m. b. H., Berlin, 1933. 12½ x 9¾ inches.

In the face of the prediction, persisting until less than half a century ago, from the narrow knowledge-range of the Middle Ages that man was facing starvation, his sudden submergence beneath a surplus of such staples as bread and other grains, fibers, and meats has taken him by surprise and aroused his interest in the reason for the sudden revolution from a crisis of threatened scarcity to a crisis of actual excess of supplies. During the last half century, with slowly accelerated speed, the investigation of the world's capacity for primary production has been in progress. The results are already considerable in the aggregate, but only lately has much effort been expended in assembling their material, making it easily available.

Such is the service rendered by Dr. Krische in the work now under review and in his "Bodenkarten" published in 1928. The present work represents Dr. Krische's continued efforts to bring together into one publication the total results of soil mapping in the field throughout the world. This work has extended to all the countries of Europe; it includes Dr. Stremme's soil map of Europe and also soil maps of the several countries and of many smaller political divisions, especially of the states of Germany. Many of these maps have been redrawn and brought into harmony by Dr. Krische, at the cost of a great deal of work, with the other maps of the atlas. In his earlier publication he was concerned mainly with *Bodenkarten*, or what in the United States would be called soil-texture maps. In the "Landwirtschaftliche Karten" his maps in many cases do not merely show soil texture but are differentiated according to soil types, the nomenclature being brought uniformly into agreement with modern usage in that respect. American pedologists will, however, criticize his selection of a soil map of the United States. The designation of the prairie soils as degraded podsols and gray forest soils cannot be accepted by American pedologists, nor can we accept the designation of the "black waxy soils" of Texas as chernozems.

In addition to soil maps, the new publication contains a great many agricultural maps showing not only the distribution of the most important crops but their yields and acreage as well. In this part of his work Dr. Krische has included the great grain crops, fibers, tobacco, vegetables, fruit, oil, rubber, and the distribution of the most important livestock products as well as the distribution of the lands of the world subjected to the several broad kinds of cultural treatments.

Nor does Dr. Krische stop here. Expressing the inevitable philosophic thought tendency of the Germans he has introduced chapters of broader considerations than national or even continental production studies. The first chapter gives, by two

small maps and a brief text, the results of the investigations of Penck, Fischer, and Hennig into the ultimate future capacity of the earth for population. In this connection he has logically included a map showing the world use of fertilizers and another showing the distribution throughout the world of institutions devoted to research in the many phases of the agricultural industry. This is followed by a somewhat longer chapter on "The Eternal Migration," beginning with brief reference to the theories of Wegener and Arlt regarding the origin of the continents and the migration of animals, plants, and man through the ages, and by an instructive small map showing the conclusions of Vavilov regarding the origin of the cultivated plants with brief mention of their migrations since man began to use them.

A third section is concerned with the influence of man on his environment, illustrated by a number of extremely interesting maps. One is a reproduction of Treitz's map of the Hungarian Plain with a brief discussion of his somewhat revolutionary conclusions regarding the changes in the character of Hungarian soils. Treitz's results, postulating a change since man began to cultivate the region from a forest-steppe and, therefore, a humid soil on the Hungarian Plain to a steppe or sub-humid to semiarid soil under the influence of man and his change in the character of the vegetation, are in harmony with the most recent results of soil investigation in this country showing that the direct action on the soil of the vegetation growing on it is of more importance in determining the character of the soil than is the direct action of the climate. This section contains also an interesting map of the middle Rhine showing the distribution of cultivated land, forest, and swamp 500 years after the birth of Christ. Krische discusses the recent development of the study and the significance of pollen preserved in peat deposits as a basis for determining the character of vegetation and succession of forests in the past.

Krische and his publishers have rendered an important service to agricultural workers, economists, and sociologists in collecting this great body of valuable material and making it available at a reasonable price.

C. F. MARBUT

THE HISTORICAL GEOGRAPHY OF AFRICA AND EGYPT

YOUSSOUF KAMAL. **Monumenta cartographica Africae et Egypti.** Vol. 1, **Époque avant Ptolemée,** 1926, 107 fols. Vol. 2, **Ptolemée et époque gréco-romaine,** Part 1, 1928, 125 fols.; Part 2, 1932, 126 fols.; Part 3, 1932, 119 fols.; Part 4, **Atlas antiquus et index,** 1933, 130 fols. Vol. 3, **Époque arabe,** Part 1, 1930, 101 fols.; Part 2, 1932, 109 fols. Folios numbered consecutively. 29¾ x 23¾ inches.

Seven volumes of this giant publication have appeared to date, each weighing more than 30 pounds. The compiler's main purpose has been to gather together geographical and cartographic materials relating to ancient and medieval Africa and Egypt. Incidentally he has sought to "assemble in a single work all the documents, written or drawn, necessary for forming an idea of the development of the conception of the world during the course of the centuries." How far down the centuries he aims to go is not announced. Dr. F. C. Wieder states in a brochure accompanying the work that "l'auteur réserve, pour un volume final, la communication des renseignements sur la composition de son ouvrage, sur l'étendue des recherches et sur les divers collaborateurs."

As completed so far, the Monumenta covers the period from the beginnings of Egyptian history to about the year 1000 A.D. Texts and maps of the most diverse character are presented, for the most part in chronological order. A place has been found for every kind of document that in any way bears on the subject, however remotely. The texts, printed in parallel columns with French translations, include writings in hieroglyphics, Greek, Latin, Syriac, Coptic, Ethiopic, Arabic, and even Chinese. Papyri, inscriptions, and hitherto unpublished manuscripts are represented, together with the published works of historians, poets, dramatists,

geographers, philosophers, and Church Fathers, and also excerpts from the Lives of the Saints, the *Notitia Dignitatum*, the Code of Justinian, legionary lists of Roman armies in Africa, itineraries, lists of bishoprics and churches, etc. All names of regions and places in Africa are printed in red.

The illustrations consist of reproductions of such early maps as the famous Madeba mosaic, manuscript *mappaemundi* and chorographic maps in Arabic, Greek, and Latin, the Peutinger Table, etc., as well as of more recent maps. Some of the latter are modern scholars' attempts to reconstruct the geographical conceptions of ancient and medieval authorities. Others illustrate various aspects of the historical geography of Africa; for example, the exquisite map of 1693 of E. Michalet showing "Les Déserts d'Egypte, de Thèbaide, d'Arabie, de Syrie, &c., ou sont exactement Marqués Les Lieux Habitéz par les Saincts Pères des Déserts." The "Atlas antiquus" (in which will be found tables of contents and an index covering the first two volumes) consists entirely of reproductions of cartographic interpretations of ancient geography dating from 1565 to the present time and is of interest for the light that it sheds on the development of African and Egyptian studies since the Renaissance.

Throughout the reproductions are superbly executed. The reviewer has seldom seen more splendid color work than that achieved in the facsimiles of some of the maps of Al-Istakhri (Vol. 3, Part 1). The immensely wide range of textual material incorporated and the clarity of the maps should render the Monumenta of value to all who can use it, although scholars engaged in intensive, highly detailed research may feel impelled on occasion to look for more critical texts. In a work of such vast scope it was out of the question to attempt textual criticism and to append notes on variant readings.

Unfortunately, owing to the limited edition, this magnificent work cannot be consulted by as many students as might seem desirable. Its sumptuous character, entailing what must be an immense cost of publication, has meant that only 100 copies are being manufactured and distributed. The work is not placed on the market but is distributed to selected institutions through the generosity of Prince Youssouf. In North America copies have been presented to the Public Archives of Canada at Ottawa, the Library of Congress, the library of the University of Chicago, the New York Public Library, and the American Geographical Society.